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BRISTOL CORPORATION AND THE TRAMWAYS.

LAST week we raised our voice in protest against the proposal of the Corporation to impose what we thought onerous conditions on the tramway company. It must not be assumed, however, that we are in the slightest degree opposed to the principle of municipal ownership, and, if necessary, municipal working, or that we object in any sense whatever to combined stations. Municipal control of central electric lighting works has proved to be eminently successful in this country, and we cannot suggest a reason why a system of electric tramways should not be worked with equally good results. We are led to make this statement because it may be assumed in some quarters that as we supported the company against the Corporation, we shall always be against Corporations working tramways. The real question at issue between the Corporation of Bristol and the local tramway company has become very much obscured, and the remarks of the "Independent Engineer," which we publish in another column, do not, in spite of his naïve suggestion, that the broad question has been "covered up with a heap of side issues," tend to elucidate the matter. It is not the principle of municipal ownership and working of electric tramways from combined works that is at issue. Reduced to its simplest form, the essential matter in dispute between the Corporation and the Company is whether the proposal to supply electric energy for the tramway extensions from the municipal works is a business-like arrangement. From the Corporation point of view, it would be an admirable means of improving the load curve. But how does the matter stand from the company's point of view? It would be an obvious injustice to expect the company to pay higher for electric energy than it costs them to manufacture, and Mr. Pearson, the able chairman of the Corporation Electrical Committee, so far recognises this, that he stated at a recent meeting of the Town Council that he would withdraw his claim to supply the current from the City station, if it could be shown that the cost to the company would be greater than the electricity would cost the company to produce. As the proposal emanated from the Corporation, the burden of proving that their supply would be cheaper than that of the company rests with them, but have they done this? We cannot conceive that the company could on reasonable grounds object to use the Corporation supply if it were cheaper than their own. But the company have now had considerable experience in electric traction; their engineers have a knowledge of what is required for tramway purposes, gained from world-wide operations, and they have come to the conclusion that it will be more expensive to buy current from the Corporation than to make it themselves, and they are fortified in this assumption by the explicit opinion of Dr. Hopkinson, who states that "in the particular circumstances at Bristol, the Corporation cannot possibly supply the current to the

Tramway Company as cheaply as the company can generate it themselves. It seems to us that the "particular circumstances" control the whole matter. Combined lighting and power stations ought in most cases to result in economy, but these necessary conditions do not obtain at Bristol. It has been urged by the advocates of the Corporation that they would not use the same plant for supplying the tramway; if that is the case how can the Corporation supply electricity with profit to themselves at a cheaper rate than the Company can manufacture it. The Corporation possess no monopoly of economical working, and if the present staff of the Bristol lighting station can look after an increased plant, the same argument applies with equal force at the power station of the tramway company.

All things considered, however, it seems a pity that the representatives of the tramway company and the Electrical Committee cannot come together and discuss the matter amicably rather than endeavour to inflame public opinion by means of common electioneering dodges. To us the real grievance of the tramway company consists in their being obliged to take current from the Corporation at enhanced rates.

ELECTRICAL PLOUGHS.

Some interesting experiments recently made in Germany in working ploughs by electromotors are described in the *Landwirth*. The experiments were carried out at Diedrichshagen, near Rostock, with the electrical ploughs of the Elektricitäts-Actiengesellschaft vorm Schuckert and Co. The fields where the experiments were carried out lay at a distance of about two miles from the generator, and the energy was transmitted by three copper wires, each 4 mm. in diameter. This is the first case in which polyphase currents have been used for working ploughs; hitherto the generator has always been close to the place where the work was done, and continuous currents with a voltage of 110 to 500 volts have been employed. At Diedrichshagen the current was supplied at a pressure of 2,200 volts, which, by means of transformers on the spot, was converted into 220 volts. The arrangement of the ploughs corresponded to that known as the two-machine system in steam ploughing, which is so called because locomotives are stationed at the edge of the field and drive a tipping plough backwards and forwards across it. Instead of a locomotive a portable winding drum with electromotor was used, which was driven with about 28 H.P., *i.e.*, approximately 75 per cent. of the power (about 35 H.P.) produced by the generator. The plough was pulled along by the electric windlass at a speed of about 50 m. a minute; it had four shares, which together produced a furrow of an average depth of 30 cm., and breadth 180 cm. For tipping the plough, advancing the electrical windlasses, and recommencing the back motion at the ends, 1½ minutes was expended each time. According to this, with a 300 m. broad field, 4,850 m². could be ploughed over in 1 hour, which amounts to 43,500 m². for a 10-hour day.

Assuming that the electrical installation is applied to other agricultural operations beside ploughing, the price of the energy may be reckoned at 0·09 mark (1d.) per horse-power per hour, which for the 37 H.P. amounts to 33·3 marks for 10 hours. The electrical installation, including conductors and plough, costs about 33,000 marks (circa £1,650); it may be estimated that it will be employed for 120 days in the year, and the interest and depreciation must be estimated from this. Reckoning this at 20 per cent. per annum, it amounts to 6,600 marks (circa £330), or distributed over 120 days,, 55 marks (55s.) per day. For attending to the plough five workmen are required, which will cost 18 marks (18s.) for wages. The total cost for ploughing the field of 43,500 m². works out to be approximately:—

For power	33	shillings.
For interest and depreciation ...	55	„
For labour	18	„
Total	106	shillings.

This reduced to the Prussian morgen (25·532 acres) as unit, gives 6 marks. In Germany steam ploughing is usually estimated to cost exactly this price, whereas ploughing with horses costs twice as much. In the above calculation the rate of depreciation is assumed to be the same as for steam ploughing machinery, but this is evidently too much for the lighter electrical machinery, for which 10 per cent. to 12 per cent. may be considered ample. The electromotors on the farm can also be applied to many other purposes besides ploughing, so that the depreciation, &c., may be distributed over 200 to 300 days, and its rate per day thereby considerably reduced. Also, the generators may be used for lighting, and such like. The costly carriage of water and coal for steam engines is also dispensed with; and all the difficulties connected with the transportation of heavy locomotives through agricultural districts are got rid of. Arrangements may also be made in some cases to supply power to neighbouring factories. For all cases, it may be asserted, that the electrical ploughing is at least as economical as direct steam ploughing, that the former is always more convenient, and under favourable circumstances is much cheaper.

Yoked to the Cataract.

On another page will be found a cutting from the *Buffalo Enquirer*. The way in which the *Enquirer* describes the whole thing, and especially the current, is *so delicious* that we have thought many of our readers would appreciate the reproduction. It is far and away ahead of any descriptive effort ever attempted here. It will be noticed that the large transformers are cooled by a current of air passing through them. The 7,000 horse-power of 10,000 volt tranformers, which Mr. Ferranti built for Deptford in 1889, were arranged with a current of air passing up between the primary and secondary coils, and also between and through the iron. They were also provided for standing on an air trough fed by a blower, but the natural circulation due to the warm air was found sufficient to keep them at quite a low temperature. It follows, therefore, that so far as the Deptford scheme is concerned, we are still ahead of our friends at Niagara in so much as here we generate the 10,000 to 11,000 volts direct from the alternator, and so avoid the transformation at the station end which they have still to employ at Niagara. It is true that they transmit their 11,000 volts 27 miles, whereas here we only did 13 miles, but on the other hand they do it by overhead wires across country, whereas on this side it had to be carried through London's most crowded streets. As, however, all this was done some seven years ago and has been going on quietly ever since in this slow old country, it is pretty well lost sight of, and the people on the other side talk of "God's own lightning" as though they were the sole licensees from the Almighty for this useful commodity.

LOCALISING FAULTS IN SUBMARINE CABLES.

By HERBERT E. CANN.

In a paper entitled "On the Localisation of a Complete Fracture in a Submarine Cable by *Bridge* Measurement to Instrument Zero," published in the *Electrician*, October 14th and 21st, 1887, Mr. Kennelly explains that when testing from one end of a cable, three measurements of the resistance of the cable conductor through the fault with different strengths of current are required when testing to *instrument zero*, instead of to *false zero*, in order to eliminate the resistance of the fault.

Mr. Kennelly gives three separate series for the ratios of

TABLES 1 AND 1A.— TABLE SHOWING DIFFERENT STRENGTHS OF CURRENTS to be used when testing for position of faults *through different resistances*.

TABLE 1.—1 *Leclanché cell* = 1·48 *volts*. TABLE 1A.—*Bridge ratios* 1,000/1,000.

Approximate resistance of line + fault.	Battery to be employed expressed in volts. Ratio 4—2—1. First test.			Nearest equivalent in Leclanché cells. Ratio 4—2—1. First test.			Battery to be employed expressed in volts. Ratio 4—2—1. Second test.			Nearest equivalent in Leclanché cells. Ratio 4—2—1. Second test.		
	A	B	C	A	B	C	A	B	C	A	B	C
Col. 1.	Col. 2.	Col. 3.	Col. 4.	Col. 5.	Col. 6.	Col. 7.	Col. 8.	Col. 9.	Col. 10.	Col. 11.	Col. 12.	Col. 13.
20	23·68	11·84	5·92	16	8	4						
40	"	"	"	"	"	"						
60	"	"	"	"	"	"						
80	"	"	"	"	"	"						
100	23·68	11·84	5·92	16	8	4	29·6	14·80	7·40	20	10	5
200	"	"	"	"	"	"	"	"	"	"	"	"
300	29·60	14·80	7·40	20	10	5	"	"	"	"	"	"
400	"	"	"	"	"	"	35·20	17·60	8·80	24	12	6
500	"	"	"	"	"	"	"	"	"	"	"	"
600	"	"	"	"	"	"	"	"	"	"	"	"
700	35·52	17·76	8·89	24	12	6	41·45	20·72	10·36	28	14	7
800	"	"	"	"	"	"	"	"	"	"	"	"
900	41·44	20·72	10·36	28	14	7	47·37	23·68	11·84	32	16	8
1,000	"	"	"	"	"	"	"	"	"	"	"	"
200	47·36	23·68	11·84	32	16	8	53·28	26·64	13·32	36	18	9
400	"	"	"	"	"	"	"	"	"	"	"	"
600	53·28	26·64	13·32	36	18	9	59·20	29·60	14·80	40	20	10
800	59·20	29·60	14·80	40	20	10	65·12	32·56	16·28	44	22	11
2,000	"	"	"	"	"	"	71·04	35·52	17·76	48	24	12
200	65·12	32·56	16·28	44	22	11	76·96	38·48	19·24	52	26	13
400	71·04	35·52	17·76	48	24	12	82·88	41·44	20·72	56	28	14
600	"	"	"	"	"	"	88·80	44·40	22·20	60	30	15
800	76·96	38·48	19·24	52	26	13	94·72	47·36	23·68	64	32	16
3,000	"	"	"	"	"	"	"	"	"	"	"	"
200	82·88	41·44	20·72	56	28	14	100·64	50·32	25·16	68	34	17
400	88·80	44·40	22·20	60	30	15	106·55	53·27	26·63	72	36	18
600	94·72	47·36	23·68	64	32	16	112·5	56·25	28·13	76	38	19
800	"	"	"	"	"	"	"	"	"	"	"	"
4,000	100·64	50·32	25·16	68	34	17	118·4	59·2	29·60	80	40	20
200	106·55	53·27	26·63	72	36	18	124·33	62·16	31·08	84	42	21
400	"	"	"	"	"	"	130·24	65·12	32·56	88	44	22
600	112·5	56·25	28·13	76	38	19	136·18	68·09	34·04	92	46	23
800	"	"	"	"	"	"	"	"	"	"	"	"
5,000	118·4	59·2	29·6	80	40	20	142·1	71·05	35·52	96	48	24
200	124·33	62·17	31·08	84	42	21	148·	74·00	37·00	100	50	25
400	130·24	65·12	32·56	88	44	22	153·92	76·96	38·48	104	52	26
600	136·18	68·09	34·04	92	46	23	159·83	79·915	39·957	108	54	27
800	"	"	"	"	"	"	165·76	82·88	41·44	112	56	28
6,000	142·1	71·05	35·52	96	48	24	171·7	85·85	42·925	116	58	29
200	148·0	74·00	37·00	100	50	25	"	"	"	"	"	"
400	"	"	"	"	"	"	177·6	88·8	44·4	120	60	30
600	153·92	76·96	38·48	104	52	26	183·5	91·75	45·88	124	62	31
800	"	"	"	"	"	"	"	"	"	"	"	"
7,000	159·83	79·91	39·95	108	54	27	189·43	94·715	47·36	128	64	32
200	165·76	82·88	41·44	112	56	28	195·36	97·68	48·84	132	66	33
400	171·7	85·85	42·92	116	58	29	201·28	100·64	50·32	136	68	34
600	"	"	"	"	"	"	207·2	103·6	51·80	140	70	35
800	177·6	88·80	44·40	120	60	30	213·11	106·55	53·28	144	72	36
8,000	"	"	"	"	"	"	"	"	"	"	"	"
200	183·5	91·75	45·87	124	62	31	219·05	109·52	54·76	148	74	37
400	189·43	94·71	47·35	128	64	32	224·95	112·48	56·24	152	76	38
600	"	"	"	"	"	"	230·90	115·45	57·72	156	78	39
800	195·36	97·68	48·84	132	66	33	236·80	118·40	59·20	160	80	40
9,000	201·28	100·64	50·32	136	68	34	242·72	121·36	60·68	164	82	41
200	"	"	"	"	"	"	"	"	"	"	"	"
400	207·2	103·6	51·80	140	70	35	248·66	124·33	62·17	168	84	42
600	213·11	106·55	53·27	144	72	36	254·56	127·18	63·59	172	86	43
800	"	"	"	"	"	"	260·50	130·25	65·125	176	88	44
10,000	219·05	109·52	54·76	148	74	37	"	"	"	"	"	"

NOTES:—To convert Leclanché into Daniell's cells (1·079 volts) × cells in cols. 5—7 and 11—13 by 1·371.
" " " bichromate " (2·000 ") × " " " " " 0·74.

Example:—

	Cells. A	B	C
When testing (if the resistance of the line + fault = $\frac{\omega}{1,000}$, see col. 1), using Leclanché cells, col. 5—7 gives	28	14	7
To give the same current when using Daniell's—			
A 28 × 1·371 = 38·4 cells—the nearest equivalent with a ratio 4—2—1 will be	40	20	10
If using bichromates (Fuller's)—			
A 28 × 0·74 = 20·7 cells—the nearest equivalent with a ratio 4—2—1 will be	20	10	5

the three currents which he finds to give the *best* results, viz, 1—4·9—, 1—2·25—16, and 1—4—16; and says:—

"The balance readings—always using zinc to line—will be found practically in *descending* magnitude, the first greatest, the third least," &c. Mr. Kennelly further remarks: "It is advisable to make E, the testing E.M.F., conveniently large, and not to employ very feeble currents."

In the *Electrician* of October 21st, 1887, p. 500, the following examples are given:—

	Ratios of	Milliamperes.
No. 1 set of measurements. current strength 1—4—9	... ...	max. = 54 min. = 6
No. 2 set of measurements. current strength 1—4—9	Ratios of	max. = 45 min. = 5
No. 3 set of measurements. current strength 1—4—16	Ratios of	max. = 56 min. = 3½

given above. The result is moreover *appreciably closer* to the true position of the fault, and may be carried out with *less than half the current strength.*

A test requiring only a battery of respectively $\frac{4}{9}$ths and $\frac{1}{4}$th the voltage required for the two Kennelly formulæ is—for a given number of cells—capable of application to very much longer lengths of cable. It will be apparent that this advantage is a highly important point in its favour, since the number of cells available at a cable hut is generally rather limited.

Three balances to *instrument* or *scale zero* are required with current strengths in the proportion 1—2—4. It is important *to test with the strongest current first* (*i.e*, in a descending ratio of 4—2—1), as any tendency to clean or open up the fault with the strongest current will, under these conditions be beneficial, since the results are more likely to be steady, and the succeeding tests with the weaker currents will be less likely to introduce a change which would detrimentally affect the *comparative* results, as may easily happen if Mr. Kennelly's reverse order of procedure be followed.

TABLE 2.—COMPARISON OF RESULTS TESTING THROUGH AN ARTIFICIAL CABLE

with a piece of core $\frac{107\ Cu}{140\ GP}$ (with conductor exposures as below) immersed in sea water to represent the fault.

~ 3 Balances to *Instrument* zero. Ratio 1,000/1,000.

Resistance of line measured at time of testing.	Calculated resistance to fault by H. E. C.'s formula. E.M.F. (various). Ratios 1—2—4.	Approximate current strength m.a. max.-min.	Calculated resistance to fault by Kennelly's formula. Ratios 1—4—16.	Approximate current strength m.a. max.-min.	Calculated resistance to fault by Kennelly's formula. Ratios 1—4—9.	Approximate current strength m.a. max.-min.
Conductor exposure ¼ inch.						
ω	ω		ω		ω	
829·5 (Cap. = 93 mfds.)	832	38— 9·5	834	38 —2·38	831	38 —4·22
,,	829	28— 7·0	838	27 —1·7	831·5	28 —3·1
,,	827	19— 4·75	...	...	840	19 —2·1
ω	ω					
1,659 (Cap. = 196 mfds.)	1,659	45—11·25	1,652	45 —2·81	1,659	45 —5
,,	1,653	30— 7·5	1,680	34·5—2·15	1,658	30·4—3·38
,,	1,656	20— 5	1,660	22·5—1·4	1,639	20 —2·22
ω						
3,270 (Cap. = 385 mfds.)	3,270	38— 9·5	3,271	38 —2·38	3,268	39·6—4·4
,,	3,267	27—6·75	3,271	27 —1·7	3,262	27 —1·7
,,	3,267	22— 5·5	3,266	22 —1·38	3,271	22 —2·44
Conductor exposure ⅛th inch.						
ω	ω					
830 (K = 93 mfds.)	835	38— 9·5	855	38 —2·4	834	38 —4·23
,,	834	28— 7·0	841	27 —1·7	...	...
,,	830	19— 4·75	...	...	...	...
ω						
1,659 (K = 196 mfds.)	1,655	45—11·25	1,667	45 —2·81	1,665·5	45 —5
,,	1,663	30— 7·5	1,666	34½ —2·15	1,666	30·4—3·38
,,	1,658	20— 5·0	1,666	22 —1·4	1,666·5	20 —2·22
ω						
3,251 (K = 385 mfds.)	3,251	38— 9·5	3,253	38 —2·38	3,256	39·6—4·4
,,	3,250	27— 6·75	3,255	27 —1·7	3,259	27 —3·
,,	3,250	22— 5·5	3,255	22 —1·38	3,250	22 —2·44

Resistance of line measured at time of testing.	Calculated resistance to fault by H. E. C.'s formula. E.M.F. (various). Ratios 1—2—4.	Approximate current strength m.a. max.-min.	Calculated resistance to fault by Kennelly's formula. Ratios 1—4—16.	Approximate current strength m.a. max.-min.	Calculated resistance to fault by Kennelly's formula. Ratios 1—4—9.	Approximate current strength m.a. max.-min.
Conductor exposure $\frac{1}{16}$th inch.						
ω	ω		ω		ω	
830 (K = 93 mfds.)	844	38— 9·5	869	38 —2·38	849	38 —4·22
,,	839	28— 7·0	850	27 —1·7	...	...
,,	832	19— 4·75	...	...	...	...
ω						
1,659 (K = 196 mfds.)	1,670	45—11·25	1,675	45 —2·81	1,672	45 —5
,,	1,666	30— 7·5	1,673	34·5—2·15	1,681	30·4—3·38
,,	1,662	20— 5·0	1,671	22·5—1·4	1,677	20 —2·23
ω						
3,251 (K = 385 mfds.)	3,255	38— 9·5	3,260	38 —2·38	3,265	39·6—4·4
,,	2,352	27— 6·75	3,261	27 —1·7	3,269	27 —3
,,	3,250	22— 5·5	3,261	22 —1·38	3,270	22 —2·44
Conductor exposure "clean cut"						
ω	ω					
830 (K = 93 mfds.)	860	38— 9·5	866	38 —2·38	874	38 —4·33
,,	856	28— 7·0	862	27 —1·7	869	28 —3·1
,,	847	19— 4·75	...	...	869½	19 —2·1
ω						
1,659 (K = 196 mfds.)	1,687	45—11·25	1,693	45 —2·81	1,689½	45 —5
,,	1,682	30— 7·5	1,693	34½ —2·16	1,689	30·4—3·35
,,	1,674	20— 5·0	1,693	22½ —1·4	1,690	20 —2·23
ω						
3,251 (K = 385 mfds.)	3,269	38— 9·5	3,273	38 —2·38	3,274	39·6—4·4
,,	3,263	27— 6·75	3,274	27 —1·7	3,263	27 —3·
,,	3,262	22— 5·5	3,274	22 —1·4	3,268	22 —2·44

NOTE.—All these tests have been taken under precisely the same conditions, *i.e.*, with the *strongest* current *to line first*, and the *weakest last.*

The resistance x to the fault by Mr. Kennelly's formula for current strengths of 1—4—9 is

$$x = \frac{A + C}{2} - 4\,(B - C),$$

and that for current strengths of 1—4—16 is

$$x = \frac{A + 2C}{3} - 2\,(B - C),$$

(where C = balance with the largest current, and A with the least).

The results obtained by the author while carrying out a series of fault tests, with various current strengths, show that the above formula may be simplified if the three current strengths be in the proportion of 1—2—4 instead of as

The *best* results are obtained with a current strength through the fault of about 20 milliamperes, or not exceeding 25 milliamperes. This is practically the same as pointed out by Mr. Kennelly in his earlier paper, giving his well-known formula for "Resistance of Faults in Submarine Cables," cf. *Journal* of the Society of Telegraph Engineers and Electricians, March, 1887.

Stronger currents may be employed, but the results are not so exact.

If the current applied be excessive, say 40 or 50 milliamperes, a considerable quantity of gas is set free at the

fault, and should the surface of exposure be small, the results will be unsteady and unreliable.

On the other hand, if the testing current be very weak, slight changes in the *earth currents* will influence the result.

For this last-mentioned reason it is desirable that the minimum current through the fault be not less than 4 or 5 milliamperes, irrespective of the surface of exposure; and if the *fault resistance* be high, as may be roughly judged by the difference between the results obtained with the different battery ratios, it is important that the maximum current should not greatly exceed 20 to 25 milliamperes.

The very wide differences between the Kennelly ratios (viz., 1—4—9 or 1—4—16) are consequently more likely, in the case of small exposures, to introduce unsteady measurements, and therefore less reliable results.

apparent, because the *actual* resistance of the fault even with only $\frac{1}{16}$th inch exposure of conductor $\left(\text{core } \frac{107}{140} \frac{\text{conductor}}{\text{G.P.}}\right)$ is practically negligible when the *maximum* current does not exceed 20—25 milliamperes. The apparent resistance, however, appreciably rises, excepting in the case of the largest exposure ($\frac{1}{4}$ inch), see tables, as the maximum testing current is increased (see Table 2A). In fact the difference in the resistances obtained with different current strengths is shown to arise entirely from the relative influence on the measurement of the polarisation set up by the testing current. It is only (1) when a positive testing current coats a very small conductor exposure with chloride of copper; or (2) when a negative current involves it in gas bubbles; or (3) when the exposure is coated with some adhesive substance,

TABLE 2A.—COMPARISON OF RESULTS TESTING THROUGH WIRE RESISTANCE

with a piece of core $\frac{107 \text{ Cu}}{140 \text{ G P}}$ (with conductor exposures as below) immersed in salt water to represent the fault.

3 Balances to *Instrument* zero. Bridge ratio 1,000/1,000.

Resistance of line measured at time of testing.	Calculated resistance to fault by H. E. C.'s formula. E.M.F. (various). Ratios 1—2—4.	Approximate current strength m. a. max.-min.	Calculated resistance to fault by Kennelly's formula. Ratios 1—4—16.	Approximate current strength m. a. max.-min.	Calculated resistanee to fault by Kennelly's formula. Ratios 1—4—9.	Approximate current strength m. a. max.-min.	Resistance of line measured at time of testing.	Calculated resistance to fault by H. E. C.'s formula. E.M.F. (various). Ratios 1—2—4.	Approximate current strength m. a. max.-min.	Calculated resistance to fault by Kennelly's formula. Ratios 1—4—16.	Approximate current strength m. a. max.-min.	Calculated resistance to fault by Kennelly's formula. Ratios 1—4—9.	Approximate current strength m. a. max.-min.
Conductor exposure ¼ inch.							*Conductor exposure $\frac{1}{16}$th inch.*						
ω	ω		ω				ω						
1,997	1,999	48—12	1,996	48—3	...	...	1,997	2,011	48—12	2,014	48—3	...	...
1,997	1,996	24— 6	...	...	1,992	27—3	1,997	2,003	24— 6	...	...	2,003	27—3
Conductor exposure ⅛th inch.							*Conductor exposure "clean cut."*						
ω			ω				ω						
1,997	2,004	48—12	2,000	48—3	...	...	1,997	2,029	48—12	2,039	48—3	...	...
1,997	1,999	24— 6	...	...	2,000	27—3	1,997	2,019	24— 6	...	...	2,028	27—3

COMPARISON OF RESULTS USING DIFFERENT CURRENT STRENGTHS

with the ratios 1—2—4 (*H. E. C.'s formula only*).

Resistance of line measured at time of testing.	Calculated resistance to fault.	Approximate current strengths m. a. max.-min.	Calculated resistance to fault.	Approximate current strengths m. a. max.-min.	Calculated resistance to fault.	Approximate current strengths m. a. max.-min.	Calculated resistance to fault.	Approximate current strengths m. a. max.-min.
Exposures ¼ inch.			*⅛th inch.*		*$\frac{1}{16}$th inch.*		*Clean cut.*	
ω	ω		ω		ω		ω	
1,997	1,997·5	50—12½	2,004	50—12½	2,011	50—12½	2,025	50—12½
1,997	1,997	40—10	2,004	40—10	2,011	40—10	2,023	40—10
1,997	1,997	30— 7½	2,001	30— 7½	2,007	30— 7½	2,019	30— 7½
1,997	1,996	20— 5	2,001	20— 5	2,004	20— 5	2,016	20— 5

NOTE:—All these tests have been taken under precisely the same conditions, *i.e.*, with the strongest current to line first, and the weakest last.

The calculated resistance, x, to the fault by the author's simplified formula, is as follows:

$$x = \text{A} + \text{B} - \text{C},$$

where

A = resistance obtained with the highest battery power.
B = " " " intermediate " "
C = " " " lowest " "

The exactness of the formula is proved by the results of many experimental fault tests, under very widely differing conditions as to surface exposure at the fault and resistance in circuit given in Tables 2 and 2A.

Strictly speaking it is an *empirical* formula constructed from the results of tests made on pieces of cable core, with the broken end of the conductor immersed in salt water, to represent the fault, and with resistance coils, or artificial cable of various lengths, in circuit.

The results show that for moderate current strengths, in the proportion 4—2—1, the resistance *at* the fault will decrease in such a ratio that the *apparent* resistance at the fault, with the weakest current used, is equal to the sum of the *apparent* resistances at the fault with the other two currents of the series. The fault resistance is spoken of as such as chalk, mud, or is buried deeply in the sea bottom, that the fault itself has a true resistance. In the first case, the application of a strong negative current will generally be able to burst open the copper salt envelope, so as to expose sufficient conductor to the water to give a reliable result. In the second case, the testing current should be reduced till the readings with the maximum current become tolerably steady. In the third case, the fault will have an increased resistance which no test can separate from the resistance of the conductor proper, and to which no law applies whereby it can be eliminated from the result.

Table 2 shows results obtained for exposures of $\frac{1}{4}$-inch to $\frac{1}{8}$-inch, $\frac{1}{16}$-inch, and also a clean cut with pliers, by Mr. Kennelly's proportional values of testing current, viz, 1—4—9, and 1—4—16, for comparison with the author's results *obtained under the same conditions*, except that the current ratios are as 1—2—4. It will be seen that the latter results in *nearly* all cases agree more closely with the measured resistance of the line at the time of testing, and that the best result is obtained when the highest testing current of the series does not exceed 20—25 milliamperes.

Although not recommended, stronger testing currents may be used without very greatly affecting the result; so that there is no necessity to calculate the *exact* current strength,

provided it approximates 20—25 milliamperes, and that the requisite *ratios* are preserved.

This will be sufficiently insured, if the battery be in good condition, by simply apportioning the number of testing cells in the ratio of 1—2—4.

To facilitate testing, Table 1 has been compiled to give the three values of battery power in volts, and also in Leclanché cells, recommended when testing for the position of an "earth fault" through various line resistances.

These have been calculated on the supposition that the bridge is employed with proportional parts 1,000 to 1,000, which values may for convenience be used for any resistance in the line circuit.

It is, therefore, only necessary to make a rough preliminary bridge test with zinc to line, and *balancing to false zero*, and then to refer to Table 1 for the three values of battery recommended for the resistance approximating most closely the conductor resistance of the cable measured through the fault.

In Table 1A a second series of alternative battery powers, *slightly* differing in strength, are in nearly all cases given which can be employed if desired as *check* tests. It is, however, clearly shown by numerous results obtained with widely different currents, that in this modification of Kennelly's test it is only a work of supererogation and waste of time to ring the changes with all possible current strengths, in order to select from them several series having the three ratios required for the test. On the contrary, changes may occur in the fault during such prolonged tests and seriously affect the results. Moreover, as the battery powers in Table 1 give the *best* results, it is better to repeat the same three tests for verification instead of changing the battery for another series under less favourable conditions. No doubt if the conductor exposure be tolerably large, the results from several series made with widely different battery power will not differ greatly, but in the case of very small exposure the error would be important.

The advantage of balancing to "instrument" zero instead of "false" zero is very important when testing a long cable, because even when a *dead beat* galvanometer is available, it is difficult to discriminate between the true *false zero* and the first rush of current due to the combined effect of the static charge and the polarisation current, which latter often falls very rapidly and introduces uncertainty. With an ordinary reflecting galvanometer, more especially the marine form, the time required for the deflection to become steady makes the *false zero* still more uncertain.

INSTALLATION TESTING.

By V. ZINGLER, A.I.E.E.

(*Concluded from page* 760.)

Supposing, however, that on turning off the switches the fault goes off, then, as said before, it is on the B side—either on the wires or fittings. The identical wire is easily found when the switches are turned off. We now disconnect this wire from the switch at one end and test—in case it should be an "earth" on this side of the switch—which is unlikely. Leaving this wire free, we next unscrew the lampholder or holders on the fitting and pull the porcelain centre down, so as to free it from the metallic fitting. If the fitting is wired with "flex," some of the little wires may be touching the side of the holder or stem of the fitting, and putting the same to earth. Such a fault can occur if the ceiling is damp, and the fixing screws for the fitting reach through the patress. Or if it is a flexible pendant, the same sort of contact may be made inside the ceiling rose. Or in the case of metallic fittings it is possible to get an "earth" if the porcelain centre of the holder is bad. If all these suggestions fail, the fault will be on the wire, either *inside* the fitting ceiling rose, or plug—or on the wire between the fitting and the switch. To locate this, disconnect the wire from the fitting by unscrewing ceiling rose contact, or lampholder screws. If the fault goes off—the fitting being a ceiling rose, it is due to damp grounds—as stated before. If the fitting is metallic it must be taken right down, th joints being cut, if there are any, at the top. It is then easy to find whether the fault is on the wire or in the fitting—or if the fitting is a mere tube, it is possible to draw the wire right out and examine it for abrasions.

If the fault is on the wire, B, it must be located in the usual manner; if inside the fitting, the latter must be rewired.

The same process is gone through if the "earth" is on the A side, only here it is arrived at quicker if there are no switches to complicate matters. Whatever the fault is, after repairing it must be re-tested before connecting up to the rest of the installation. The latter must also be re-tested in order that when the fault has been found there does not remain anything behind to cause the same work to be done all over again.

Of course it is possible that the fault will be discoverd without all the tests here indicated.

For instance, the switch and fuse-board may be perfectly insulated, and then the faulty sub-main or circuit can at once be located by turning off the sub-main switches.

In cases of three-wire system, the testing becomes a little more complicated, especially if the three wires are taken beyond the fuse-boards. In this case the lamps should always be taken out on both sides together, and the tests made on A, B, and C as before, B having, however, two sets of tappings. As regards switches, these should always be fixed on one pole in the two-wire system, or on the middle wire in the three-wire system (if the middle wire is carried so far). This is the proper way of doing things, and simplifies any future difficulties.

If the switches have not all being fixed on one side, they must be located, by connecting the instrument to one line wire, taking out the lamps and "earthing" the switches by hand, or a piece of wire, one by one.

When faults are found on marble or slate, the remedies and causes have already been dealt with. If however, the fault is on a wire in casing, it may be either due to a nail driven through the casing into the wire; a flow of water which has spoiled a joint; or mechanical injury to the insulation of the wire before it was cased up. In all cases, examine the casing and capping in question as far as it is in sight. If nothing is discovered, take a convenient place about half way between the two ends under test, and cut the wire—after locating as far as possible the right wire. Pricking should not be resorted to; it is better to cut every wire and make a fresh joint. After cutting the wire, test both halves, and if the length of casing is too long to warrant taking off all the capping, cut again.

In any case, the circumstances and conditions of the building must determine the mode of action, and the tester must use his own judgment.

If the system is pipe-work, the location of the fault is much easier, as the faulty wire has merely to be cut and drawn out. In this case, the "earth" may be due to two causes—mechanical or chemical. The first is caused by an abrasion in the wire, either previously existing or made on drawing in, the wire being torn by coming against the corner of a box or a jagged edge, or split by violent pulling round a bend.

In the latter case, the braid or rubber may be rotted by the introduction of foreign substances, such as lime or oil. The latter may be present, owing to screwing of pipes in a screwing machine. The oil should always be most carefully wiped off, as it is fatal to rubber.

As regards switches, a cause of leakage which is not generally known, is found in the type of switch which has a metallic cover screwed on to the base. If this cover is screwed on and off many times, the sharp edges of the china thread, which is much harder than the brass cover, causes a plentiful sprinkling of brass dust inside the switch. This conducts the current from the contacts to the fixing screws and thence, if the grounds are damp, to earth. This is much more apparent where switches are sunk in the wall than where they are on the surface. Another cause of leakage in switches of every sort and plugs also, is the neglect of the wireman fixing them, to strip back the braid for about 2 inches, before entering the contact. The braid being porous absorbs moisture, and if the system of casing is metallic, we have an "earth" at once.

Again, if sunk switches are used, and a metallic finger plate be laid flush on the wall, the switch handle should be

well insulated (if metallic), or else if the walls are damp, there will be another source of leakage. The remarks about switches apply also to fittings and ceiling roses. Where ceilings or walls are damp, all grounds should be soaked in paraffin wax, or else the fixing screws should be bushed with ebonite. Insulators on electroliers are not much good, as they collect dust and moisture and frequently crack. The question of holders has been dealt with, but if time permits, holders should be carefully tested, especially switch holders.

As regards lamps, especially those with vitreous insulation, the resistance between contact and collar is often very low, and if any fitting is badly insulated for causes before stated, the circuit becomes faulty. It is well to test lamps also before supplying them to customers for an installation for which you are responsible.

In dealing with short circuits, the method of testing should be carried out in the same way as for "earths." The only difference is that the cause is found much more quickly, and the remedy is usually simpler.

It is exceptional to find a short-circuit in a casing or pipe unless a nail has been driven into the former, or the insulation has rotted in the latter. The more frequent cases are in fittings wired with "flex," or in lampholders.

A source of leakage between poles not generally known is found in plugs of the 2-prong order, mounted on china bases. These should always be carefully tested beforehand, especially if they have been long in stock, as the screws in the china are apt to go mouldy.

The writer has frequently been asked by wiremen and others to indicate a method of procedure for quick testing. There is, however, no hard and fast rule to set down, beyond adopting some method of elimination as here indicated, and using one's common sense. That this may be neglected and time lost, by beginning at the wrong end, or in the middle, with no fixed idea of proceeding, is evident.

However, so much depends on the honesty of the men employed that in electrical installation work it is best to give a good man constant employment, instead of paying him off after every job, when something cannot be found for him immediately. For if he knows he has to go, he will not interest himself in the work nor study his employers. All this may seem irrelevant to the question just discussed, but on it hangs a great deal of the causes of an employer's profit and loss.

For no man will be in a hurry to locate a fault if he knows that he will be paid off directly he has found it. And therefore the question very often resolves itself into one of the struggle for life, as well as the employment of common sense; and what the employer may lose by keeping on a good man when he has got him—even at a slack time—will be trebled if that man knows he will be paid off when his job is done. And as the employer does not undertake installations for the joke of the thing, but to make them pay, it is hoped that these remarks will be appreciated as having the most direct bearing on the keeping down of expenses in the testing of installations.

THE MEASUREMENT OF TEMPERATURE OF FILAMENTS IN INCANDESCENT LAMPS.

No uniformity exists as to the temperature data of incandescent lamp filaments published up to the present; indeed, the figures are most discordant, as may be seen from the following:—

1886.—Garbe	2,250°	Centigrade.
1891.—Weber (Zurich) ...	1,300°	„
1892.—La Châtelier ...	2,800°	„

It is well known with what rapidity the light emitted varies with the temperature of the filament; but it does not seem possible that there should be such grave differences in the temperature of glowing filaments as those given above.

In *La Revue d'Electricité*, P. Janet explains the principle of a new method for measuring temperatures of incandescent filaments, which he claims to give accurate results. This method consists in determining experimentally, by means which are subsequently indicated, the amount of heat given out by a lamp filament when it cools down from its normal temperature of incandescence to that of the air, and then equating the quantity thus determined with the product of the calorific capacity of the filament by the unknown lowering of temperature.

Let R be the resistance of the lamp filament, which, as we know, is a function decreasing with the temperature, t, of the filament. We are then able to write the equation:

$$R = \phi(t),$$

where ϕ is an unknown function.

On the other hand, the energy emitted by the lamp during unit time is a function of the temperature of the filament. However, this energy is nothing more than the power, P, supplied to the lamp. We are able, therefore, to put

$$P = \phi(t),$$

and hence to consider R as a function of P,

$$R = f(P).$$

This last function can be determined experimentally. Let us take an electric lamp and submit it to differences of increasing potential, measured exactly at the terminals of the lamp, and noting at the same time the intensity of the current. We are able to determine the resistance of the filament in each particular case, thus, as the power E, I of the current. We deduce from these values a first curve representing the variations of the resistance, R, in the function of the power of the current, R, being expressed in abscissæ, &c., E, I, by the ordinates.

Take, now, the same lamp, and submit it to its normal voltage; then at a given moment sharply interrupt the current. The filament begins to cool slowly from the unknown temperature, $t°$, to that of the known temperature of the air. If we determine the law according to which this cooling down works in the function of time, and we know already from the first curve, the power given out at each temperature considered as a function of the resistance, we are able to determine the total amount of heat emitted by the filament during its cooling down.

In order to determine this law, Janet measures the resistance of a filament at different periods of the cooling down. The measurement is made in the following way:—The lamp is thrown into a Wheatstone bridge circuit as soon as the lighting current is interrupted. This is easily effected by means of a special commutator. The bridge is regulated beforehand for a resistance, $R + r_1$, very near that of the hot filament. It is traversed by a current sufficiently feeble not to heat the filament to any apparent extent. At the same time, as the current is interrupted, a timepiece measuring seconds is set going, and as soon as the equilibrium of the bridge is established, the stop-watch, or whatever the timepiece employed may be, is arrested. Thus we determined the length of time necessary for the temperature to fall to the value represented by the resistance, R, to the resistance, $R + r_1$.

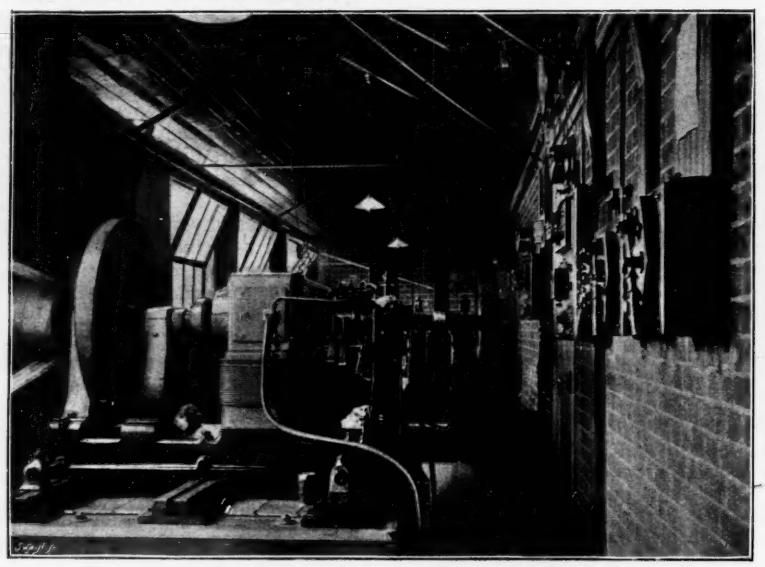
The same experiment is repeated for resistances, $R + r_2$, $R + r_3$, $R + r_4$ . . . . the value rising in each case, commencing by bringing the lamp to its maximum temperature, and then letting it cool. Thus the curve representing the decreasing resistances of the filament in the function of line is determined point by point. This curve giving at each instant of cooling the resistance of the filament, the first curve which gives the energy emitted per unit of time for each value of the resistance, enables the energy emitted at this instant to become known. If then a third curve be constructed, the time being expressed by abscissæ, and the energy emitted per unit of time by ordinates, the area of this curve will represent the total amount of heat expressed in electric units lost by the filament during its cooling down.

But this same quantity may be expressed in terms of the weight of carbon in the filament, of the maximum temperature $t°$ (degrees Centigrade) of the filament, and of the calorific capacity of the carbon. Consequently, by equating this expression to the value determined, we are able to derive t if we know the other quantities, once the curves obtained by a large number of experiments have been traced, the filament may be broken and its weight estimated, and then the only other unknown quantity remaining besides t that would be the calorific capacity of the carbon employed in the filament, and this Janet considers may be obtained according to

Violle's experiments (*vide Comptes Rendus*, cxx., p. 869). Janet, however, has not yet completed all his experiments, and it may be some little while before he is able to publish his complete results. However, he has now made public the method which he has discovered, and so made it possible for other electricians to use it.

CHALFONT PARK ELECTRIC LIGHT INSTALLATION.

This plant was put down by Messrs. Drake & Gorham in October, 1893, under the supervision of Messrs. Lea and Thornberry, consulting engineers, Birmingham, to their specification. There were several reasons which led to the adoption of petroleum engines, viz., the distance from a railway station, which made the cost of fuel for a steam plant high, and the fact that the stream which passes near this installation was only capable of giving about 3 H.P. Therefore, it was decided to use petroleum engines, and Messrs. Priestman Bros., of Hull, specially designed the two engines with extra massive parts and bearings and to be capable of running for long periods; they also guaranteed a full 11 H.P. on the brake, with only a consumption of 1¼ pints of oil per H.P. per hour. The engines are fitted with self-starters, and two massive fly-wheels give very steady running. Current for ignition is taken from two cells of the accumulator. The Electric Construction Corporation supplied two shunt-wound dynamos, and also compounded, with short-circuiting plug for running direct, the compound coils being cut out while charging accumulators. Their capacity is 60 amperes and 135 volts, and an extra bearing with fly-wheel was provided in order to get steady running when working direct. Each dynamo is provided with its own switchboard and measuring instruments; the boards are made of enamelled slate and fitted with ammeter, fuse block, Nevile automatic cut-out, and main switch mounted thereon, an Ediswan engine room voltmeter being fixed over dynamo switchboards with two-way switch. The accumulators consist of 60 19-plate D.P. cells capable of giving 90 amperes for four hours. These supply current for the early morning and Sunday night supply. In the switch room are fixed two enamelled slate boards with ammeter, double-pole main switch and fuses, also a Nalder voltmeter for lighting circuits. On a table is fixed a Nevile automatic accumulator switch, which is controlled by a solenoid so adjusted that it keeps the voltage between 108 and 110 volts without attention. The mains (Callender's, laid in bitumen) are carried from the switch-room board to distributing board in the house, about 70 yards away. The lighting mainly consists of 16 and 32 C.P. lamps, 110 volts being employed. The wiring is arranged for 293 lamps, equal to about 500 8-C.P. The stables, yards, and engine room, are lighted by 32 C.P. "Improved Glow Lamp Company's" lamps, all the others being Ediswan. The plant has been found to answer admirably, so far as maintaining the supply is concerned. With petroleum delivered at 6d. per gallon, the cost per unit used is about 4¼d., including wages, but not depreciation, but the plant is not being worked at full load; a trial run with one engine fully loaded worked out at 3¼d. per unit generated. All metal fittings were supplied by Messrs. Benson, and the cut glass ones by Messrs. Osler. Each fitting is protected by its own fuse, placed as close to the switch as possible, so that in the event of a short circuit, only the one particular fitting is affected. A counter-shaft is placed at the back of one engine, so that the water supply can be worked at the time of charging; but as it only leaves a margin of about 3 H.P., it is not of much use for battery charging when pumping is being done.



Chalfont Park Electric Light Installation.—Engines and Dynamos.

ON A NEW METHOD OF READING GALVANOMETER DEFLECTIONS.*

By C. B. RICE.

A method of reading deflections of galvanometer needles and analogous apparatus has recently been devised by Prof. C. S. Hastings, and has been tried with very satisfactory results. The magnetic needle of the galvanometer arranged for the new method is a circular steel disc of 1 cm. diameter, polished on both sides for convenience, serving as a mirror, hung between two coils of wire with a silk suspension of about 5 cm. The coils are of No. 36 wire, with an outside diameter of 2·5 cm., and have a resistance each of 6 ohms. The brass covers which fit over the coils are provided with openings closed by glass so that there is a clear view of both faces of the magnet, while air currents are excluded. A small aperture of 1·4 mm. diameter in the centre of the steel mirror permits a view of objects beyond which lie sufficiently near the axis of the instrument. Facing the coil and the magnet within, but at a trifle higher level, is placed a small lens at a distance adjustable from 5 to 7 cm. from the magnet. On the opposite side, at a similar adjustable distance from the mirror, is fixed a fine point, preferably of some dark material with a white background. Directly under the lens is a small scale. The image of this scale, as formed by the screen, is seen superimposed upon the image of the fixed point, as seen through the aperture in the mirror, and any change in the angular position of the mirror causes a relative shifting of these two images, which, under proper adjustment, are in the same plane, and are, therefore, perfectly free from errors of parallax. The use of the lens serves the double purpose of reducing the linear dimensions of the apparatus, and of giving such precision to the ocular accommodation, that the edges of the hole in the magnet, as well as the fixed image of the scale, due to the glass windows, are so far out of focus as to be quite invisible. When the lens point and small scale are once adjusted, the instrument is ready for use at any time with no further attention. If the support be moderately level, no levelling screws are necessary.

With this galvanometer a potential of $\frac{1}{100000}$th of a volt

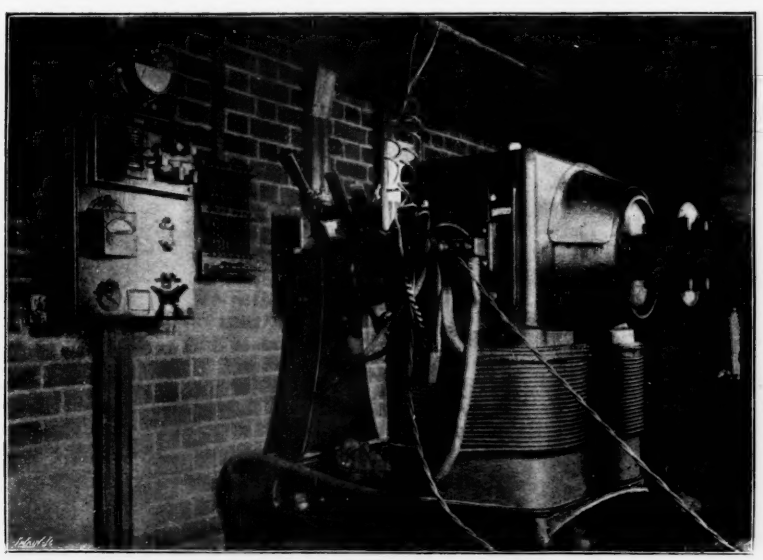
* Abstract from the *American Journal of Science*.

is readily detected by repeated closing of the circuit—a sensitiveness which is more than sufficient for a large part of the elementary work of the laboratory.

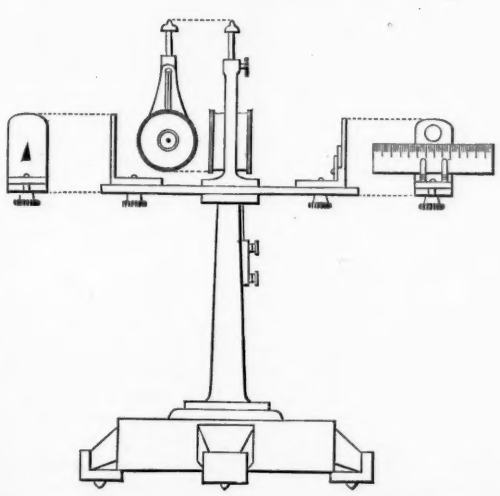
The simplicity and cheapness of this type of galvanometer make it very desirable, while its lack of delicacy is of considerable moment where the care of it falls upon the novice.

There seems to be no reason why this method for reading deflections should not be used with all other galvanometers as a substitute for the telescope and long scale. The angular measures are read with great accuracy, and with much greater precision than with the lamp and scale of Thomson's method. The small scale used in this connection should be divided into half millimetres, for the reading is made with clearness to tenths of such an interval.

The instrument figured is one of those constructed at the laboratory, and must be looked upon simply as an example of a convenient, moderately sensitive, but widely useful form. The two coils are separated by a copper ring about 3 mm. in thickness, which produces a certain damping, although the galvanometer serves very well for ballistic use. Notwithstanding the moderate damping, the actual time required to secure a succession of readings is certainly not greater than is found necessary in using a Wiedemann aperiodic galvanometer, because the period is so greatly reduced. In an astatic system with long period, more effective damping would doubtless be desirable, but in such a case there would be no difficulty in employing Thomson's ingenious air damping.



Chalfont Park Electric Light Installation.—Dynamos.



New Method for Reading Deflections of Galvanometers.

It is obvious that a needle constructed of small steel magnets cemented to silvered glass, the silver being removed from a small portion, might replace, and in some cases advantageously, the steel mirror.

INTERNATIONAL TELEGRAPH CONFERENCES.

The brief translation of the *Proceedings* of the Conference at Buda Pesth, 1896, which have appeared in recent issues of this Journal, do not appear to point to excessive legislation or alteration. There is an apparent conservatism in the deliberations, which leads to the belief that the time set apart for business was not enough to permit any great change to be made, even had such been the desire of the delegates assembled. A book of propositions of some 200 pages issued before the conference was almost alarming, and it gave rise, to the uninitiated, of visions of some vast change. The French Administration made most praiseworthy efforts to bring many of the regulations into something like order, and met with a little encouragement, as the adoption of some of their propositions will be embodied in the 1897 book of regulations.

The long interval of time between Conferences—five years—leads to one thing being well done, the accumulation of work for settlement; but a nice counterpoise exists, viz., six plenary meetings in as many weeks, of people of all nationality endeavouring to speak in the same tongue. It is not surprising, therefore, that the accomplishment of the greatest amount of work in the shortest possible time, plus amusements, proved to be somewhat impracticable. During the five years' interval circulars are issued by the Berne office; replies demanded are sent or not as one thinks fit, and there the matter ends, instead of being disposed of in such a manner as to need only the reading in the minutes of the Congress as showing their formal adoption. The object, therefore, which may be usefully considered now is to obtain an arrangement whereby alterations may be as quickly as possible considered and put into force, and not left until an accumulation overwhelms their consideration. It may be said in support of this arrangement that an alteration is more valuable at the time it is conceived, than five years later. There seems to be no method other than a periodical meeting in each country of the administration and responsible members of private companies at not longer intervals than one year, or oftener, as necessity arises. The regulations as they exist at present do not appear to provide an agreement between the companies, and they will always remain more or less inoperative so long as there is an absence of power similar to that of the Companies Acts to guard against their infringement, and for their enforcement. It should also be possible among companies adhering to the Convention to be indemnified against any loss arising from an infringement of the regulations when they occur affecting traffic, and it is a question whether a penalty clause should not be inserted in the Convention, as it seems only reasonable that advantages should be met by corresponding responsibilities.

We have considered the plan which might be adopted to make an effective contract, but the attempt at carrying it out would be neutralised in England if all companies had a vote, by reason of the preponderance of power.

The few companies unaffected by the Trusts and Pools could not attempt to assist in the framing of a binding contract, as they would in all cases be out-voted.

The issue of an official vocabulary was, it is to be hoped,

practically shelved at the last Conference. The one issued some time ago is still causing great irritation, and the directors of the Glasgow Chamber of Commerce adopted a memorial to the Postmaster-General, which coincides with the opinion of many telegraph people in Great Britain.

The last issue of the *Chamber of Commerce Journal* contains an application made by Berne to merchants to supply at their own cost large and expensive code books. Such an application cannot be justified, as it must be known to Berne that many codes used have never been set into type, but are written from time to time as exigencies arise. It seems possible that a universal code of well-known words, as short as possible, would be some help towards speed and accuracy, but the question is so important, and the alteration would cause so much dislocation of business, that the issue of an official volume might well be allowed to lapse if it cannot be built up and issued by members of the Chambers of Commerce, the telegraph administrations and company's representatives together.

It cannot be considered quite satisfactory that, while there is a means of communication, useful signs and indications cannot be transmitted. The position is somewhat of the nature of a phonograph minus the diaphragm.

The following punctuations, other signs, &c., have no symbol, or might be modified, and the following suggestions are made. *E.g.*:—

Equal	sign =	B	T
Multiplication	„ ×	E	X
Division	„ ÷	D	N
Per cent.	„ %	X	V
At	„ @	E	J
Plus	„ +	A	R
Request to transmit	„	G	
Understood	„	O	K
End of transmission	„	S	N

Signal used for separating the preamble from the address, the address from the text, and the text from the signature, should be I I instead of B T.

FIGURES.

M M M or M to be replaced by

Horizontal stroke as ⅔	A	D
Vertical stroke ⅗	U	S

OFFICIAL INSTRUCTIONS.

It is, perhaps, not quite recognised at Berne, that if symbols are to be used, their utility is increased proportionately as their length is decreased, therefore it is suggested that—

Telegram with reply paid x words... ...	R	X
„ urgent with reply paid	R	D
„ „ „ „ „ x words ...	D	X
Acknowledgment of postal receipt	C	L
Post restante registered	P	E
Service rectification	S	T
„ ordinary	S	G
Telegram to follow by post	F	P

The value of shortening the length of indications is obvious, and there seems to be no reason whatever why a letter should be used for every word to be indicated, nor is there any reason to fear that a multiplicity of signs would lead to confusion, as it is not an onerous matter for counter clerks and operators to master and commit to memory a great many more symbols than already exist.

It may be also questioned if the confusion of S R and S T should prevail, but on the other hand their abolition might be considered a decided advantage. If a commodity other than a telegram is dealt in, competition is keen enough and provides a proper completion of contract. It would not be to the benefit of a merchant if he supplied goods in a mutilated condition, and he would have very little business if he demanded a money deposit before making good defective deliveries. But before a telegram may be corrected a deposit is demanded, and as the greatest number of those using the telegraph are business men, it may be safely said they would not ask for a repetition for the sole purpose of wasting their time. Telegraph companies could prevent any abuse in this direction.

The *Journal Télégraphique* naïvely states that plans are more easily formulated than realised; but this cannot be said of the existing regulations for they are without end, and form a book which station officials very often look upon as being there for anything but their guidance. There is, therefore, little doubt of there being room for revision—rearrangement and simplification.

THE GERMANO-SWISS SOCIETY'S NEW ACCUMULATORS.

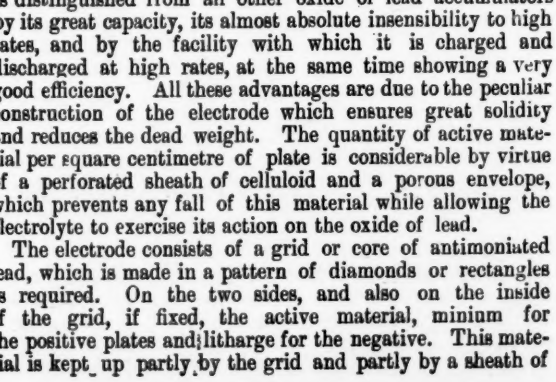
As we have already said, writes Ch. Eug. Guye, Professor in the Zurich Polytechnic School, in an article contributed to *L'Eclairage Electrique*, on "Electricity at the Swiss National Exhibition," the Germano-Swiss Society of Fribourg has exhibited a battery of 140 elements for the new type of accumulators. This battery, of a capacity of 1,500 ampere-hours, is used for the lighting of part of the exhibition from 10 p.m. to 5 a.m., but it constitutes at the same time a reserve for lighting in case of accident. When working normally it feeds six or seven series of four arc lamps, each consuming 12 amperes, or from 72 to 84 amperes. The maximum output would correspond to 20 series of four lamps, or 240 amperes, and the experiments made for several days with this output proved very satisfactory.

The elements themselves are arranged in 10 series of 14 accumulators, each of which can be disconnected from the circuit by means of a commutator. In case of accident, or of deterioration of one of the elements, the working is not interrupted.

The regulation of the battery is effected by means of 28 elements, arranged on two tables; each key of the reducer comprises two elements. The regulation is, therefore, performed by degrees of 4 volts.

We have already seen how the charging of the battery is effected by means of the Alioth commutator and the survolteur. This charging is performed at the rate of 150 amperes, which corresponds to 2 amperes per kilogramme of electrodes. These are particularly advantageous conditions, as the maximum discharge current can attain to 240 amperes.

The construction of the accumulator itself is shown in the fig., and we think it would be advantageons to give a few details on this subject. These details were furnished at our request by M. Geinoz, the engineer, and seem very interesting.



The accumulator of the Fribourg Germano-Swiss Society is distinguished from all other oxide of lead accumulators by its great capacity, its almost absolute insensibility to high rates, and by the facility with which it is charged and discharged at high rates, at the same time showing a very good efficiency. All these advantages are due to the peculiar construction of the electrode which ensures great solidity and reduces the dead weight. The quantity of active material per square centimetre of plate is considerable by virtue of a perforated sheath of celluloid and a porous envelope, which prevents any fall of this material while allowing the electrolyte to exercise its action on the oxide of lead.

The electrode consists of a grid or core of antimoniated lead, which is made in a pattern of diamonds or rectangles as required. On the two sides, and also on the inside of the grid, if fixed, the active material, minium for the positive plates and litharge for the negative. This material is kept up partly by the grid and partly by a sheath of

perforated white celluloid (guaranteed pure), which prevents its disintegration, while allowing it to dilate or contract.

Inside this sheath, or between the celluloid and the active material, is a porous envelope, which still further increases the protective action of the sheath.

This sheath of perforated celluloid (shown in the fig.) consists of two covers fitting one into the other and cemented together, when once the electrode is filled with a solution composed mainly of celluloid.

The construction of the plate is effected in the following manner:—

To the interior of the inner cover is applied the porous partition already mentioned. Over this partition is spread evenly half the quantity of oxide of lead contained in the electrode. The grid is next applied to the layer of oxide; the other half of the oxide is then spread on this grid; then come the porous envelope and the inner cover which fits into the outer cover.

The electrode thus prepared is closed and then immersed in a special bath which is different according as the electrodes are positive or negative. After having been left for some minutes in the bath, the plate is subjected to pressure (varying according to its size). The object of this pressure is to give the oxide, which has been rendered pasty by the soaking, the required consistency, and at the same time to enable the superfluous liquid to escape. The electrode is then dried under pressure, and afterwards placed in the open air for a few days. All that now remains to be done is to close it at the connections and to strengthen the covers of the positive electrodes at the place where they are closed. The plates are then ready to be made up into elements.

The positive plates are then separated from the negative by rods of celluloid attached to the positive plates themselves.

The formation takes place in a bath of sulphuric acid at 23-24° Baumé. After being from 10 to 12 hours in this bath the positive plates are formed at the same time, and coupled into elements with the negative plates. The first formation charge takes place at the rate of 3 amperes per kg. of plate, and it lasts 20 hours, then 2 hours at the rate of 2 amperes, and 2 hours at the rate of 1 ampere, or 24 hours altogether. The first discharge is effected immediately after, at the rate of half an ampere per kg. of plate, and is prolonged until the element has attained an E.M.F. of 1·8 volts. The capacity at this first charge is from 9 to 10 ampere-hours per kg. of plate.

The second charge then takes place at the rate of 3 amperes per kg. of plate during 10 hours, after which the discharge is effected at 1 ampere per kg. The capacity attains to about 14 ampere-hours.

The third and the following charges up to complete formation are effected at the same rate as the second.

After five or six charges we obtain 20 ampere-hours per kg. (capacity guaranteed for stationary batteries), to a fall of voltage of 10 per cent.

For a well-performed formation, this capacity attains to 23-24 ampere-hours per kg. of plate, and an E.M.F. of the element of 1·8 volt.

In the case of a charge at 1 ampere per kg. of electrodes, the mean charging voltage is about 2·3 volts, and the maximum voltage 2·6 volts.

The mean E.M.F. at the discharge of 1 ampere per kilogramme of electrodes is 1·97 and 1·98 volts, and is at the commencement of the discharge 2·07 and 2·08 volts. These figures show the advantage of this accumulator from the point of view of the mean voltage, which is very high.

The efficiency in ampere-hours and watt-hours is for a charge at 1 ampere per kilogramme of electrodes, and for a discharge at 1 ampere per kilogramme of electrodes, 92 per cent. in ampere-hours, and 78 per cent. in watt-hours.

For a charge of 2 amperes, and a discharge of 2 amperes, these efficiencies are 87 per cent. and 70 per cent.

For a charge at 3 amperes, and a discharge at 3 amperes, they are 77 per cent. and 62 per cent.

These last figures show that the efficiency is comparatively high for charges and discharges at high rates, as compared with that of other types of accumulators.

The maximum charging current is 3 amperes per kg.

The maximum discharging current is 3·5 amperes per kg.

This discharge can, however, be increased to as much as 10 amperes per kg. of electrodes in the case of elements specially prepared for traction purposes, without involving any risk of a fall of material.

The above figures bring out prominently the following advantages of this accumulator: high capacity and high efficiency; facility of charge and discharge at high rates with a comparatively high efficiency, and without any fall of active material.

These advantages, together with that of great solidity, are, as we know, great recommendations. We may add that the society guarantees these accumulators for two years without extra charge, and for several years at a fixed annual charge.

We may also note the employment of a new celluloid lid. This lid is made so as to prevent any spilling of the acidulated liquid resulting from a shock. It consists of two celluloid compartments, kept together by means of rods, also made of celluloid; one, two, or four holes, according to the size of the box, are made on the sides of the upper compartment, and in the lower compartment towards the centre. In this manner, the orifices not being opposite one another, the liquid projected between the two sides cannot run out through the upper compartment, when the inclination of the box is of short duration. In order to facilitate the return of the liquid that has been precipitated into the lid, we can incline the box towards the centre of the lower compartment. This lid is used principally in portable batteries.

A CRITIC CRITICISED.

In order to hear the other side of the questions raised at Bristol in regard to the electric tramways, we discussed it with an independent engineer, whose comments are essentially as follows:—

"I hardly think the writer of the leading article in the current issue of the Electrical Review, respecting the Bristol Tramway dispute, can possibly have compared side by side with an unprejudiced mind the two reports therein alluded to, otherwise he would—having a fair mind—have felt convincingly the speciously clever, yet terribly weak and illogical, criticism of Mr. Preece's report by the engineer to the tramway company.

"Dealing only with the technical points involved, there is mutual agreement, first, as to the trolley system being the best all round; and so say all of us. Then comes the chief cause of battle:—'The remaining point to be considered,' says the tramway company's engineer, 'is whether or not the electricity for such a system can be more economically supplied from a lighting station such as now exists in Bristol, or from a station specially designed to meet the tramway company's requirements, and specially managed by their own staff?' Mr. Preece gives no such alternatives whatever. If his report means anything at all, it advocates—certainly not a supply for tramway work from the present lighting station, since it is fully taken up with its lighting load, but—the provision of plant specially designed to meet the tramway company's requirements, though (and here comes the difference) under the management of the Corporation staff. It is not fair to give any other interpretation of his words.

"The engineer then goes on to set forth what has been the custom in the United States, regarding which he may have had much experience; but we are not obliged to follow in this country a line of policy which may suit another. To say that electric lighting and traction supplies are always separated in America proves nothing at all; as a matter of fact, it is due to the supply being in most cases in the hands of entirely separate interests or companies, and not to any supposed opposition in the quality or character of the supply. The 'rolling mill' analogy of electric traction power demands is apt enough; but the hydraulic press of equal power—worked most economically by an engine perhaps one-tenth the size, with the aid of an hydraulic accumulator—offers a much better simile for the engineer of sound economical instinct. Mr. Parshall has apparently, however, had but little experience, and less confidence, in the use of electric accumulators, which he seems to decry throughout, although he installed them both at Dublin and Bristol itself for lighting the tramway company's own premises.

E

"The next statement amounts to this, that in a station where current is supplied for traction and lighting, the total cost per unit increases as the output increases; at any rate, Mr. Preece points out that the *reduction* of total cost per unit as the output increases, may be seen very notably at several places, Manchester in particular. Mr. Parshall says that this may be true, where lighting only is done; but with combined working, 'the opposite would probably be found to be the case.' That is, the total cost per unit increases as the output increases. I cannot easily imagine conditions under which such a state of things could arise; but am willing to ascribe my inability to dense ignorance. Even if entirely separate electric plant must be employed, the steam generating gear and the power-house buildings are not thereby doubled, whilst the management expenses ought not to materially increase at all.

"Then the Hamburg station is dealt with. This we are told was designed for tramway work; yet Mr. Parshall finds fault with it in the next paragraph as an electricity works, because it did not extend quickly enough to give all the current required for the tramway. Any defect or deficiency in supply is surely to be met by special clauses in coming to a primary agreement between generator and user, and does not affect the technical question of successful combined working so far as economy is concerned. The same deficiency in supply of current might easily have occurred if the tramway company generated its own current. What the average wage of motormen—next considered—has to do with combined working of electric light and traction, it would be difficult to say; but the point is urged apparently in order to damage the excellent figures as to total cost, &c., given by Hamburg.

"Then there is mentioned the fact that 100 tons of batteries are employed at Rome for 12 cars, to provide for the overlap of traction and lighting loads in the evening; and the inference is drawn that at Bristol some 1,500 tons would similarly be required. Mr. Parshall forgets to explain that at Rome a large portion of these batteries is used for regulating the pressure, instead of acting as an accumulator or reservoir; and he thereby missed an opportunity of saying a good word for that very ingenious and useful American device of the 'booster dynamo,' the employment of which would render unnecessary a large part of the batteries at Rome.

"Perhaps one of the most interesting points to notice follows upon this: and it brings up again the old saying, that figures can be made to prove anything. Mr. Preece is found fault with for taking 300 days in the year when calculating out the total car mileage per annum. But he also takes the full number of cars in stock, leaving the odd 65 days to represent the loss of car mileage due to repairs, cleaning, &c. Would Mr. Parshall propose to run every car in stock the maximum car mileage per day for 365 days in the year? Yet that is what he states; so that the thrice happy Bristol Tramway Company is never to have a single car laid up to be cleaned or repaired! It doesn't need a repair shop; not a motor will ever be burnt out or controller go wrong; or, if they should so misbehave themselves, the damage will be repaired between 1 and 4 a.m.

"The 'error' thus said to be committed by Mr. Preece, as a matter of fact, is really to be laid at Mr. Parshall's own door; and his rhetorical effort to show the amount of this 'error' to be four times the total quantity of electricity generated last year at the Bristol municipal station therefore loses all its point.*

"There is no need to deal with the more or less cautiously worded endorsements of Mr. Parshall's report by Lord Kelvin and Dr. John Hopkinson. Probably Mr. Preece himself would quite agree with the substance of all they say—which doesn't amount to much, any way. As to the broad question involved, people seem to have lost sight thereof, and to have allowed it to be covered up with a heap of side issues. The chief points to discuss are:—First, Is it possible to generate current more cheaply from one power house for traction and lighting than from two; second, if so, is the Corporation or the tramway company to have the sole and entire power of supply?

"If the reports would only stick to these points, it would then be an easy matter to digest them comfortably, and I need not have framed this modern instance of Sartor Resartus, more especially as no big fee is attached to it, thanks to the ingratitude of a general public."

* We fail to see the logic of the above argument. Whatever may be the number of cars in operation, or how many laid up each day, Mr. Preece has certainly overlooked the fact that tramways are run every day of the year, and the reasoning adopted to shift this "error" on to Mr. Parshall is too shallow.—Eds. Elec. Rev.

CORRESPONDENCE.

The Bristol Tramways Question.

I take the opportunity of saying one or two things which seem to me more or less *àpropos* of the subject, but I fear that I have not hitherto followed it sufficiently to deal with the entire question to the extent that its importance demands.

Your leading article in this week's issue of the Electrical Review seems to indicate a position strongly hostile to combined working of electric light and tramway plants, based apparently upon the opinions of Mr. Parshall, and backed up by authorities of no less standing than Lord Kelvin and Dr. John Hopkinson. Assuming that good grounds exist for such a conclusion with respect to Bristol, considering the conditions that obtain locally, I should much regret to learn that owing to such expressions regarding one particular place and set of circumstances, the general idea should go forth that combined working can seldom, if ever, be profitable or desirable.

I feel sure that none of the above-named gentlemen would wish such a conclusion to be drawn; yet the probability is, that unless properly explained, the proceedings at Bristol will have a very great and depressing effect upon municipal tramway development in many places, where electric lighting stations now exist.

I do not, of course, propose to criticise either of the reports published: both Mr. Preece and Mr. Parshall are doubtless well able to defend the positions that they have assumed. From the outsider's point of view, however, it certainly seems to be a storm in a teacup, and a matter capable of easy arrangement. For my own part, I do not see why the logical common sense of the Bristol Corporation should not have led them to treat with the Tramway Company for the purchase of the present tramway power-house, coupled with the erection of another by the local authority in the centre of the city, or an extension of the municipal electric lighting station for the same purpose. The entire supply of electric current would then be in the hands of the Corporation, as in the case of numerous other towns; and they could very well afford to sell current to the Tramway Company at a lower rate than the latter could generate it.

It is decidedly anomalous to allow the Tramway Company to have a small power-house but not a large one; unless the former is to be regarded as something of an experiment, a repetition of which cannot be allowed as a matter of municipal policy. To bring the matter down to a practical issue, I think few will deny that for economy's sake the entire supply of current for light and power might well be in the hands of one interest, either the Corporation or else the Tramway Company! Mr. Preece apparently recommends the former; Mr. Parshall would not object to the latter, I presume. Both may be arguing on sound technical grounds, and only differ fundamentally on a point of municipal policy.

The only engineering point that requires special mention and emphasis consists of this undoubted economy in generating current by putting the entire traction and lighting supply under one staff and management, and as far as possible into one station, so that the boiler plant and buildings need only be slightly enlarged instead of doubled as would be the case with two stations. With a high pressure alternating current electric light supply, the steam and electric plant would, of course, in either case increase almost directly with the load, but accumulators can well be employed to even it up in stations based on a low pressure continuous current system. The capital outlay is in the latter instance not any less; it will probably be more; but the working expenses ought to decrease considerably and should overbalance the extra interest on greater capital expenditure.

Your note last week entitled "Begun at the Wrong End," goes into this matter, and deals with it in a somewhat novel

yet interesting fashion. Evidently the Bristol Tramway Company's engineers aspire so high as to be the chief generators of current in the city. In that case, let the lighting supply be tacked on to the traction system, if only to save the cost of management, not an inconsiderable item in itself.

Frank B. Lea.

We note in your issue of the 11th inst. that in your leading article on "The Bristol Corporation and Electric Traction" Mr. Parshall is stated to have reported to the Corporation that "Storage batteries in large systems are not considered economical or practicable."

The conditions obtaining at Bristol do not for the moment concern us, but we cannot allow such a statement to pass unnoticed, for it may perhaps interest you to know that the Union Traction Co. of Philadelphia, operating 500 miles of road, have in use a chloride battery with a maximum discharge rate of 400 H.P. for one hour. Last year it was decided to extend the line several miles, and it was found that the cost of copper alone to carry out this extension and double the service on the section would be four or five times the total cost of a battery installation, and that a new power house was out of the question on account of the heavy operating expenses. Current curves taken under normal conditions show that the battery regulates to the extent of 200 H.P. The load on the section varies from 1 to 700 amps., the feeder carries a constant load of 400 amps., the battery charging or discharging to the extent necessary to maintain this condition. There are 248 cells connected in series. Every traction engineer will testify to the advantages of having the generators running always at full load and some device to act as a cushion to the engine in the event of the circuit breaker opening when trouble occurs on the line, and these conditions can only be satisfactorily fulfilled by the use of accumulators.

Further, the fact that the average load in traction work amounts to less than 50 per cent. of the maximum load which has to be provided for, must of itself appeal strongly to engineers as to the value of the storage battery in connection with electric traction.

We may add that we have supplied batteries for this purpose to the Douglas and Laxey Tramway Co., the Snaefell Railway Co., and the Stockholm and Djursholm Railway Co., in every instance with marked success, so much so that at the moment we have several other batteries for this class of work on order, and under negotiation.

Chloride Electrical Storage Syndicate Limited.
G. A. Grindle, *Manager.*

[We spoke of the instance of the use of accumulators at Philadelphia in our issue of Nov. 20th.—Eds. Elec. Rev.]

What Electric Lighting Really Costs.

The papers on the cost of electric light to the consumer, running now in your paper have interested us very much. We find it a very difficult matter to get reliable information on this subject. We would like to instal the electric light into a new Hotel we are now building, but the uncertain nature of our inquiries as to cost seem to be a great barrier to its adoption. If we installed it throughout we have over 200 16-C.P. lights (some of these, of course, 8 C.P. but totalling 16 C.Ps.) The price here at 4½d. per unit reckoning each light at 1,000 hours per annum comes out at over £200 per annum. We can make it cheaper we are told, but can we rely upon interested firms' statements? Next, we have all the worry and anxiety, if anything should go wrong with the gas engine. We question whether the company would give us a switch, if we start making it, in case of necessity. Next we have such a number of fluctuating lights that the question of accumulators comes in. Next the cost of installation, gas, wages, up-keep of accumulators, &c.

Now we are firmly of opinion that if you gave a paper or series of papers relative to such questions as these—beginning at the point where it becomes cheaper to *make* than to *buy* electricity—you would be doing a good turn to such would-be users as ourselves, who are deterred by considerations such as we have shadowed forth as above.

W. & J. Suttie.

[We will endeavour to devote a column to this next week. —Eds. Elec. Rev.]

The Institution of Electrical Engineer's Meeting.

The enthusiastic spirit of reform which animated the Annual General Meeting of the Institute of Electrical Engineers must have given to those present the pleasurable feeling which always accompanies a united and earnest desire for progress and development.

All the suggestions made were good and no doubt will receive due consideration from the executive; no one will dispute that it would be a great improvement to hold the conversaziones in either the Queen's or Albert Hall, doing away with the crush and having in addition to the usual attractions a selection of scientific experimental demonstrations, thus making the occasion as it should be, worthy of the presence of the highest in the land. This I presume is only a question of time.

The suggestion, however, put forward by Mr. E. Manville that the Institution should design and prepare certificates of membership of the Institution, to be issued to those members who require them, a fee to be charged for each certificate issued, so that the innovation be self supporting, deserves, I think, attention in the immediate future.

It may not be generally known to the Council that the fact of being a member of the original English Institution of Electrical Engineers carries considerable weight abroad, and it is important to possess other evidence of membership than the mere name in the list. I have been informed by electrical engineers in the Argentine Republic that such is the case, and I herewith endorse Mr. Manville's suggestion with regard to this matter in the correspondence columns of your paper as being more likely to attract general notice to his suggestion, and perhaps call forth comments from others interested.

G. H. B.

Design of a Bi-polar Dynamo.

I shall be greatly obliged if you would obtain me an explanation of the following from Mr. Kennedy through the medium of your excellent paper:—

In the articles on bi-polar dynamo design we are told that the ampere turns for the armature are got by multiplying the length of the path by 10. Does this mean that the total number of ampere turns for armature is this amount, or that it is only the number per unit? In other words, supposing the machine were of the "Tyne" type with only one magnetising coil, would you multiply the armature path by 10 or 20, to get the ampere turns? There is one other point I should like to draw attention to. In rule 7 we are told that the number of "*turns*" on the armature is found by the formula given, but later on the "number of wires counting all round armature" is substituted. One usually considers a "turn" as one complete convolution, and in a drum armature the number of *turns* will be equal to the number of *wires* divided by 2, will it not?

Thanking you in anticipation and hoping I have not trespassed excessively on your valuable space, and that I shall be able to get information on the subject.

Ivon M. de Havilland.

Shunt Winding of Dynamos.

Among Mr. Rankin Kennedy's useful and practical rules for the design of small dynamos, which appeared in your last issue, the method described for determining the wire required on the magnet bobbins appears to me needlessly lengthy, and not quite to the point.

The amateur, we are aware, has the greatest reverence for anyone who can tell him what is the number of *pounds* of wire which he must put on his armature, and, once furnished with this data, he will give no further trouble. It is, therefore, quite conceivable that, for the same reason, he will not be happy until he knows what is the number of *turns* of shunt wire which he must wind on to his magnet bobbins. Mr. Kennedy, advisedly perhaps, tells him this; and, moreover, he lays some stress upon it, he says: "This method of trial and error is the only way to arrive at the winding which will meet both requirements, namely, the number of turns and the resistance . . . ." Now, it seems to me—and, surely, in this I am not mistaken—that the number of turns and the resistance are the very two things which Mr. Kennedy is gradually finding out by his method of trial and error.

If, however, we determine first the size of the wire, the length, and, therefore, the resistance, and the number of turns for any given current density can be obtained by a reference to the wire table, and a simple proportion sum.

The most usual method of calculating shunt windings is that given below, in which I use Mr. Kennedy's figures. It seems to me both simpler and shorter. The one thing to remember is, that the voltage, E, on the terminals of the bobbin being constant, the ampere turns will depend only upon the average resistance of the wire *per turn*, and for the same average length per turn, *are independent of the number of turns*.

Resistance per turn

$$= \frac{\text{E}}{\text{Number of ampere turns required}}$$

$$= \frac{100}{10{,}212{\cdot}5}$$

Resistance per 1,000 yards

$$= \frac{\text{E} \times 1{,}000}{\text{Number of ampere turns} \times \text{mean length per turn}}$$

$$= \frac{100 \times 1{,}000 \times 3}{10{,}212{\cdot}5 \times 2{\cdot}5} = 11{\cdot}75 \text{ ohms},$$

which, allowing for a 10 per cent. increase of resistance with temperature, brings us practically to No. 17 S.W.G.

A. S.

December 14th, 1896.

Free Lamps.

I am pleased to see that you have revived the question of "free lamps." In March last I made a similar suggestion at a meeting of the Institution of Electrical Engineers, but the matter went no further.

It cannot be denied that in the majority of cases complaints made by consumers as to the electric light being unsatisfactory, generally intended as a reflection on the supply or the installation, originate in the lamps being bad and inefficient. One cannot suggest that supply companies or those interested in the installation of electric light are impeccable, but the makers of cheap lamps are greater sinners still. Lamps sold by philanthropic makers at less than cost price tell their own tale, and it is not within our province here to enquire what becomes of defective and inefficient lamps. These do more harm than anything else to the reputation of the electric light as an illuminant, and they cost the consumers dear in the long run; but experience shows that the consumer requires to be protected against himself, he cannot realise that three pence saved on a lamp means in most cases three shillings extra cost on current for the same amount of illumination. I would not say that all cheap lamps are bad, but no one can be blind to the fact that a good and, therefore, efficient lamp requires greater skill and more supervision in manufacture, and therefore of necessity costs more. Even suppose that two manufacturers produce at the same cost to themselves lamps of different quality, the better article of the two must in the long run command the higher price. Nor does it follow that the increased consumption due to cheap lamps means anything more than a temporary gain to the supply company: in the long run it means loss. Permanent success depends on a large and popular demand, which in turn depends not only on an essentially regular supply of current, but still more on an efficient lamp of even quality. The latter statement is amply illustrated by the fact that the electric light with a 2-watt lamp, if obtainable, and current at 1s. per unit, would be cheaper than the electric light with a 4-watt lamp and current at the present City price—8d. per unit.

I can imagine nothing more conducive to permanent progress than the disappearance of low-grade lamps, and this is a matter that the supply companies can control better than anybody else by adopting some such method as that introduced at Bradford. There are many difficulties in the way, but none of them insuperable. It does not mean a gigantic monopoly for any one lamp maker, provided that the many firms who now claim to make "the best lamp" can substantiate their claims, as the supply companies could distribute their orders. It is found practicable in New York for the Illuminating Company to photometer every lamp before it is sent out to the consumer, and the same should be practicable here.

It may be urged that it would be impossible to supply fancy lamps: that is quite true, but the large users of fancy lamps generally belongs to that class of consumer which is not entitled to any rebate, as it makes a heavy call on the resources of the company for about three months in the year, which means that a corresponding amount of capital is locked up in mains and plant, and therefore idle during the remaining nine months.

As everybody now knows, it is the regular consumer that pays, and he is the one entitled to rebates in the form of free lamps in proportion to the amount of current consumed per lamp.

When the new lamps are delivered the old ones can be taken in exchange and broken up, thus rendering it impossible for the consumer to sell the new lamps or use them for purposes for which they were not intended.

H. W. Handcock.

Flexible Cords and Fire.

I should like to be permitted to make a few remarks on the paragraph in this week's Review on "Flexible Cords and Fire," as I consider that it is calculated to cause needless alarm to the users of flexible cords. If cords such as described were in general use in this country, there could be no question as to the "need of better cords," but though my firm has made flexible cords in considerable quantities from the commencement of their use, it is a thing entirely unknown to manufacture such without at least one covering of pure or compound rubber, this being in my opinion absolutely indispensable.

Users will find that there are plenty of good cords in the market to which lint will not adhere, and others which "could not be set on fire."

The wonder in this case is not that one or two of these "cheap and nasty" cords fired, but that they did not all do so.

W. Rickard.

[We are compelled to hold over, by reason of lack of space, letters from Mr. Clement E. Stretton, Mr. A. B. Pescatore, Mr. Louis J. Steele, and Mr. Walter Rowbotham.—Eds. Elec. Rev.]

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the annual general meeting held on Thursday evening, the 10th inst., the report of the Council was read as follows:—

ANNUAL REPORT OF THE COUNCIL, 1896.

Elections, 1895.

The total number of additions to the register during the year has been 246, comprising eight foreign members, 14 members, 128 associates, and 96 students; and 58 candidates have been approved for election next month.

Twenty-two associates have been transferred to the class of members, and 72 students to the class of associates.

Deaths and Resignations.

The losses which the Institution has sustained by death, although greater than last year, are not above the average.

They are as follows:—

Three Foreign Members.—L. Beckwith, W. C. A. Staring, and Dr. A. Stoletow.

Five Members.—Andrew Bell, F. S. Harwood, J. Thewlis Johnson, H. J. Vose, and Gordon Wigan.

Fifteen Associates.—E. W. Adamson, Edward Burn, Augustus Calder, G. F. Clements, A. T. Durrant, W. Eccles, H. L. Harris, H. C. Hodges, J. A. Kingdon, A. Langman, E. J. Lecoat, H. C. Oates, C. H. Phillips, J. R. Pickering, and C. M. Stobart.

One Student.—A. H. Gossage.

Mr. Staring, a past director-in-chief of the Netherlands Telegraphs, was one of the original members of the Institution. Mr. Andrew Bell, who was for a long period connected with the Postal Telegraph Department, had been a member for 20 years. Mr. J. Thewlis Johnson was one of the original members, and Mr. Gordon Wigan had been a member for 23 years.

Four foreign members, nine members, 21 associates, and seven students have resigned during the year.

Papers.

Besides the valuable inaugural Address of the President, the following papers have been read during the year:—

Date.	Title.	Author.
Feb. 27th.	"High Voltage Lamps and their Influence on Central Station Practice."	G. L. Addenbrooke, Member.
Mar. 26th.	"Telephone Exchanges and their Working."	Dane Sinclair, Member.
April 30th.	"On Railway Telegraphs with Special Reference to Recent Improvements."	W. Langdon, Member.
May 14th.	"Experimental Tests on the Influence of the Shape of the Applied Potential Difference Wave on the Iron Losses of Transformers."	S. Beeton, C. P. Taylor and J. M. Barr.
May 28th.	"The Utilisation of Water Power especially with a Small Fall, with some Examples of Plants for the Generation of Electrical Energy."	A. Steiger.
Nov. 12th.	"The Telephone Trunk Line System in Great Britain."	J. Gavey, Member.

The list is smaller than usual, owing to the circumstance of the discussion on the two papers read in November of last year having occupied two of the meetings of this year.

Annual Premiums.

In respect of the papers read during the Session 1895-96 by others than members of their own body, the Council regret that only one is of that character, and possesses sufficient merit to entitle the authors to a premium, viz.:—

"Experimental Tests on the Influence of the Shape of the Applied Potential Difference Wave on the Iron Losses of Transformers," by Messrs. Stanley Beeton and C. Percy Taylor, students, and James Mark Barr.

To the authors of this paper they award the "Institution Premium," and having regard to the fact of the authors being three in number, they intend on this occasion to increase the value of the premium from £10 to £15.

Of the papers read at the students' meetings, the majority have been of considerable merit, and the Council have decided to present upon this occasion two premiums of £3 3s. each. They award one of these to Messrs. E. Ray and V. Watlington, for their paper on "Underground Conductors," and the other to Mr. E. B. Wedmore, for his paper on "A Simple Method of Analysing Harmonic Curves."

The Council have pleasure in making honourable mention of the following papers:—"Post Office Form of Wheatstone Bridge," by G. Lemmens; "Electricity Supply Meters," by G. W. D. Ricks.

Salomon's Scholarship.

The Council have awarded a scholarship of £50 to Mr. E. W. Marchant, a student of the Central Technical College.

Students Class.

The Council have observed with satisfaction not only the continued improvement in the character of the papers read at the students' meetings, but also an increased activity on the part of the students committee in other directions.

Your Secretary was able to arrange for visits by parties of the students to the following works and stations during the session, viz.:—Messrs. Willans and Robinson's works, Thames Ditton, the St. Pancras Electric Light stations, Messrs. Siemens Bros. works at Woolwich, the Metropolitan Electric Supply Co.'s station, the City of London Electric Supply station, Bankside, the London Electric Supply Co.'s station at Deptford, the General Electric Co.'s "Robertson Lamp Factory," Brook Green, and the Board of Trade Laboratory (by kind permission of Major Cardew).

To the above-named firms and the engineers of the several companies the Council desire to acknowledge their appreciation of the kind facilities thus afforded to the Students of the Institution.

In September last a visit by some of the Students to Switzerland was organised by permission of the Council, and your secretary was enabled, chiefly through the good offices of Dr. du Riche Preller, member, and Mr. A. Steiger, to obtain for the party special facilities for inspecting many of the most important electrical and engineering works in that country, their reception being of the kindest character.

Fire Risk (Wiring) Rules.

The final revision of these rules has been purposely delayed in consequence of the sanctioning by the Board of Trade of the use of higher voltages, rendering necessary considerable further alterations in and additions to the rules.

The Council have made a grant of money from the funds of the Institution for the purpose of enabling the committee to carry out tests of switches, fuses, and other appliances, as now supplied by manufacturers, in order to ascertain how far these are suitable for the increased pressures.

A committee was appointed by the Council on May 28th to consider the Council's expenditure in the direct advancement of the electrical industry, and whether, having regard to the annual surplus, the time has not arrived for greater expenditure in that direction, and to report.

Annual Dinner.

The annual dinner, which was this year held at the Criterion Restaurant on November 25th, was largely attended, the chief guest on the occasion being the Duke of Norfolk, Postmaster-General.

Annual Conversazione.

The Conversazione was this year again held in the Galleries of the Royal Institute of Painters in Water Colours, and was very numerously attended.

Building Fund.

In accordance with a resolution passed at the meeting of Members and Associates on July 6th last, certain stocks, representing at the price of that day the sum of £3,500, have been transferred to the Building Fund account, and the interest accruing therefrom has been, and will be in future, credited to the same account, and will be invested from time to time.

It is a striking and satisfactory proof of the sound judgment exercised by your honorary treasurers, the late Mr. Edward Graves and Sir David Salomons, in making the Institution's investments, that the increase in value of the stocks so transferred to the building fund between the date of their purchase and that of their transfer, was no less than £221 1s. 5d., which sum figures in the balance-sheet as profit added to the general fund.

Annual Accounts and Financial Position.

In accordance with the resolution passed at the ordinary general meeting of March 12th last, the statement of accounts and balance-sheet for the year ending December 31st, 1895, as then presented, were re-cast, and were in their new form adopted at the special general meeting of Members and Associates held on July 6th.

Among the alterations made in the articles of association by the special resolution previously alluded to, was one enacting that the financial year should thenceforth be taken to end on September 30th in each year, and that the annual accounts should in future be made up to that date, and laid before the annual general meeting next following. Accordingly, the statement and balance-sheet to be presented this evening only covers the nine months comprised between January 1st and September 30th last.

The accountants have considered it desirable to make some further slight modifications in the form of these accounts, but they are framed substantially on the same basis as those adopted last July.

It will be seen that the receipts exceed the expenditure during this period of nine months by the amount of £887 19s. 6d., and this is without debiting the receipts with anything on account of outstanding subscriptions (the estimated realisable value of which on September 30th was £532), as, had this been done, the accounts would have shown 12 months income against only nine months expenditure, with the result that the balance then shown would have been misleading. When the next year's accounts are made up, this difficulty, of course, will not arise.

The sum of £801 3s. has been invested during the year on account of general investment fund, and £75 on account of life compositions.

As announced by the President at the ordinary general meeting of November 12th, Sir David Salomons found it necessary, in consequence of the many calls upon his time, to decline nomination this year for re-election as honorary treasurer.

The Council greatly regret that such should be the case, as although under the revised articles of association Sir David Salomons could no longer have remained a vice-president, they had hoped by his re-election as hon. treasurer to continue to have the benefit of his advice, which has hitherto proved of so much value.

Amendments in the Articles of Association.

With a desire to meet, as far as was desirable in the general interests of the Institution, various suggestions which had reached them, your Council appointed a special committee to consider in what direction the articles of association might be amended with advantage, the result being that a series of amendments were submitted by the Council to a general meeting of members only, on the 15th June last, and adopted by a unanimous resolution, which was duly confirmed and thus made a "special resolution" under the Companies' Acts, on July 6th.

The Council earnestly trust that these amendments will work satisfactorily, and will tend to strengthen that feeling of confidence which should subsist between the general body of members and their elected representatives.

The Library.—Report of the Secretary.

I beg to report that the accessions to the library during the year number 53; of these 5 were purchased, the remainder having been kindly presented either by the authors or the publishers.

The specifications of all electrical patents continue to be supplied to the Institution by the kindness of H.M. Commissioners of Patents.

The number of patents applied for this year, up to November 25th, was 26,425, of which 1,314 or 4·97 per cent., were electrical.

The corresponding numbers last year were 22,442 and 1,367, or 6·09 per cent.

The periodicals or printed proceedings of other Societies received regularly are, with some few additions, the same as last year.

The number of visitors to the Library to the end of November has been 654, of whom 67 were non-members.

The corresponding numbers last year were 743 and 116 respectively.

F. H. Webb, *Secretary.*

Before putting the motion for the adoption of the report, the president invited members to offer any remarks they might desire to make, and the following members took advantage of the invitation, viz.: Messrs. A. A. C. Swinton, R. S. Erskine, E. W. Parsone, Charles Bright, C. E. Grove, C. B. Clay, E. Manville, and Major Flood Page.

The suggestions made embraced the following subjects:—

That technical exhibits and experiments should be shown at the Annual Conversazione; that the Session should commence and end on the same days as the financial year; that better papers and on more varied subjects be obtained; the earlier issue, if possible, of advance proofs of papers; the issue of diplomas of membership; and finally, the proposed tests by a Committee of the Institution, of electrical fittings and other appliances suitable for the higher voltages now sanctioned by the Board of Trade.

The President replied to all but the last of these, to which he deputed Mr. Crompton to reply as chairman of the Committee on the New Wiring Rules, in connection with which the tests are to be made.

The Statement of Accounts and Balance-sheet for the nine months ending September 30th were then adopted.

The usual votes of thanks to the Institution of Civil Engineers and to the officers of the Institution, were duly carried, and also a special vote to Mr. Aylmer, local honorary secretary for France, the announcement of whose resignation of the office through illhealth was received with much regret.

There having been no other nominations made for the election of new Officers and Council for the year 1897 beyond those made by the present Council, the following were announced to have been all duly elected:—

PRESIDENT.

Sir Henry Mance, C.I.E., M.Inst.C.E.

VICE-PRESIDENTS.

Robert Kaye Gray.
Prof. S. P. Thompson, D.Sc., F.R.S.
Prof John Perry, D.Sc., F.R.S.
Joseph W. Swan, F.R.S.

ORDINARY MEMBERS OF COUNCIL.

G. Von Chauvin.
Henry Edmunds.
S. Z. De Ferranti.
W. E. Langdon.
Prof. J. A. Fleming, M.A., F.R.S.
Dane Sinclair.
S. L. Brunton.
Prof. J. A. Ewing, F.R.S.
W. P. J. Fawcus.
Major R. Hippisley, R.E.
E. Manville.
J. S. Raworth, M.Inst.C.E.
Herbert Taylor, M.Inst.C.E.
James Swinburne, M.Inst.C.E.
Charles Henry Wordingham.

ASSOCIATE MEMBERS OF COUNCIL.

Captain W. P. Brett, R.E.
H. W. Miller.
Sydney Morse.

HONORARY AUDITORS.

Frederick C. Danvers.
Augustus Stroh.

HONORARY TREASURER.

Prof. W. E. Ayrton, F.R.S., Past-President.

HONORARY SOLICITORS.

Messrs. Wilson, Bristowe & Carpmael.

Mr. Raworth expressed on his own behalf, as well as of others, great satisfaction with the manner in which the Council had met the various suggestions offered this time last year, and which they had given effect to by means of the amendments in the Articles of Association.

He specially alluded to the active part which the President had taken in this matter, and moved a hearty vote of thanks to him and the Council. This was cordially seconded by Major Flood Page and was carried unanimously.

BUSINESS NOTICES, &c.

Gazette Notices.—Mr. James Todd, the receiver and manager in *re* Bennett & Druce (*in Chancery*), has issued the following notice:—"In order that the creditors may thoroughly understand the present position of matters, I have to inform you that the contracts are now practically worked out, and I am applying for payment of the amounts due. Certain adjustments will have to be made regarding the amounts invoiced for extras, but subject to these and other detailed adjustments the work is completed. I am arranging for an early sale of the stock-in-trade by auction, and when this and the other items referred to are complete, no time will be lost in bringing the matter to a conclusion."

The *London Gazette* contains notice that Thomas Edelston, of Preston, official receiver and trustee in *re* P. C. Pope, electrical engineer, of 6, Castle Street, Hapton, near Burnley, was released on November 13th last.

Business Announcement.—Messrs. J. P. Hall & Co. announce that Messrs. Girdlestone & Co. no longer represent them in London. For the present all inquiries and orders should be sent direct to the firm at Oldham.

Catalogue.—A thick catalogue which has been issued by Messrs. A. Gallenkamp & Co., of Cross Street, Finsbury, is devoted chiefly to chemical and sundry laboratory apparatus, but about 20 pages on toward the end contain descriptive details and illustrations, also prices of a great variety of electrical plant and accessories. Among these are electrolytic apparatus, platinum apparatus for electrolysis (Prof. Classen's designs), Gülcher thermopiles, small dynamos, small motors, galvanic batteries, Daniell cells, vacuum tubes, helium or argon tubes, Puluj's electric apparatus, radiometers, Hofmann's, and various other lecture apparatus. The catalogue is an exceedingly useful publication.

Electrical Wares Exported.

Week Ending Dec. 15th, 1895.	£	s.
Adelaide	126	0
Alexandria. Telep. mtl.	55	0
Algoa Bay	10	0
Amsterdam	250	0
Bilbao	76	0
Bombay	191	0
Brussels	236	0
Brisbane. Teleg. mtl. ...	130	0
Calcutta	40	0
„ Telephone mtl.	129	0
Cape Town	183	0
Delagoa Bay	68	0
Demerara	26	0
East London	331	0
Flushing	46	0
Hamburg	20	0
Hong-Kong	231	0
Kurrachee	15	0
Madras. Telephone mtl.	43	0
Malta	398	0
„ Telephone mtl.	43	0
Melbourne	225	0
„ Teleg. mtl. ...	419	0
Monte Video	30	0
Port Natal	45	0
Revas	28	0
Shanghai	109	0
Singapore	23	0
Sydney	27	0
Teneriffe. Teleg. mtl. ...	185	0
Wellington	2,964	0
Total	£6,706	0

Week Ending Dec. 15th, 1896.	£	s.
Adelaide	66	0
Amsterdam	30	0
Auckland	72	0
Bilbao	583	0
Calcutta	199	0
Campana. Teleg. mtl. ...	172	0
Cape Town	895	0
Christiania	24	0
„ Teleg. wire ...	24	0
Delagoa Bay	43	0
Durban	764	0
East London	508	0
Flushing	122	0
Melbourne. Teleg. mtl.	198	0
Ostend	44	0
Passages	425	0
Port Elizabeth	200	0
Rangoon	39	0
Rio Janeiro. Teleg. mtl.	66	0
Rosario	97	0
Rotterdam. Teleg. mtl.	52	0
Santos	316	0
„ Teleg. mtl.	570	0
Stockholm Teleg. mtl.	96	0
Suez. Teleg. mtl. ...	9,360	0
Sydney	1,406	0
Vera Cruz	37	0
Total	£16,408	0

Foreign Goods Transhipped.

	£	s.
Passages	£91	0
Total	£91	0

Concert.—The City of London Electric Lighting Company's staff held a "smoker" at the Masons' Hall Tavern, Basinghall Street, on 15th inst, the chair being filled by Mr. F. H. Jackson (assistant engineer), supported by Mr. J. Cecil Bull.

Electric Organ.—An organ to be blown electrically on the Hope-Jones system, at a cost of £1,800, is to be put in at the Stourport Parish Church. A bazaar has been held to defray the expense.

Gas.—On 12th inst., a gas explosion was caused at Lyon Street, Glasgow, through searching for a leakage in the usual manner. Injury to life and property resulted.

On 9th inst. a gas explosion occurred at Swain's coffee-house, Tooley Street, wrecking the shop and kitchen.

A gas explosion occurred at 13, Croham Road, South Croydon, on 10th inst., the house being partially wrecked and furniture damaged.

Liquidation Notices.—A general meeting of the Arc Accumulator Company will be held on January 22nd, 1897, at 39, Victoria Street, S.W., at 3 o'clock, to hear an account of the winding up from the liquidator, Mr. Edgar R. James.

A similar meeting of the Foreign and Colonial Arc Accumulator Company, Limited, will be held on the same day, at the same place, at 3.30 o'clock.

Röntgen Tubes.—An improved form of tube, patented by Prof. Zehnder, and manufactured exclusively at the Hard Incandescent Lamp Factory, Zurich, has a regulator by which after long usage the tube can be restored to its original intensity. With these tubes a clear photograph can be obtained by an exposure of 15 seconds. The London agents are Messrs. Wilhelm & Co., 132, Wool Exchange.

Wood Casings.—We have before us a sample and list of painted electric casings which are being supplied and stocked by Messrs Beecroft & Wightman, of Bradford, in response to the expressed wish of customers, for electric light casings and covers ready painted.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The question of electrically lighting the streets is to be considered by the Watching and Lighting Committee.

Ashton.—Mr. Clirehugh, in reporting regarding the electric lighting of the streets, stated that 150 arc lamps would be required. The Committee has asked Mr. Clirehugh to reduce the number to 60 in preparing his scheme. His plans of station buildings have been approved.

Athlone.—A proposal has been made to extend the gas works, but several of the Commissioners would prefer an electric light installation.

Ayr.—At the last Council meeting the following incident occurred. Mr. R. Craig pointed out that the present engines had never passed the parallel test, and had never been certified by the engineers.—Provost Willock: Do you mean the existing engines?—Mr. Craig: Yes.—Provost Willock: Oh, that is a mistake.—Treasurer Meikle: Yes, it is a mistake.—Mr. Pink, electrical engineer, said the existing engines had not been certified as having passed the parallel test. Treasurer Meikle stated that the consulting engineer had stated that the engines had stood the parallel test for nine hours. Before they settled that question they should refuse to accept Mr. Pink's statement until they had inquired of Mr. Hammond, their consulting engineer.—Baillie Auld did not think it was right in Mr. Pink to make the statement he did, as Mr. Hammond showed Mr. Pink on one occasion how the test was done.—Mr. Pink (excitedly): That statement is absolutely false.—Provost Willock: I don't think it is becoming for an official to call a statement made by any member of Council absolutely false.—Mr. Pink: My reputation is as dear to me as Mr. Hammond's is to him.—Dean of Guild Girvan: No official has the right to get up and speak without permission. I think Mr. Pink should apologise for what he has said. The matter then dropped.

Battersea.—The Vestry is to at once purchase Grove Wharf and Canada Wharf from Mr. G. Neal for the sum of £8,500, and land and premises in the Lombard Road from Mr. Audoire for the sum of £5,400, both being necessary for the electric light station site.

Belfast.—The engineer is giving consumers notice that on and after the 14th prox. the pressure at which electric current will be supplied to them will be uniformly 220 volts in place of 110 and 220 as heretofore, and that fittings would have to be provided to suit the pressure in future.

Bradford.—The Corporation want a jointer for the electricity supply works. See our "Official Notices."

Bray.—The *Sunday World* (Dublin) last week had a short paragraph regarding the extensions which are to be carried out at this station. That paper remarks that if the improvements and extensions to the plant now it is in the Town Commissioner's possession are to cost £5,000 odd, "it might have been a cheaper and more satisfactory process to start brand new works instead of endeavouring to patch up old ones." The absurdity of this remark shows that the writer knew very little about the matter. He discredits the statement that such a sum is correct, and then makes an even worse blunder by saying that if the statement is correct, "few will question that the ratepayers of Bray will pay dearly for their luxury." The facts of the case given on the best authority are as follows, and the *Sunday World* would do well to bear them in mind:—The Bray Town Commissioners bought from the liquidator of Gordon & Co., for £3,060, an electric light station with a complete system of mains laid all over the town, and with a complete system of public lighting, which had cost £12,000. The station as purchased just paid its way, but could make no profit for want of extra plant, which the liquidator had no power to supply. The Commissioners are wisely spending £5,000 on plant and buildings to enable them to increase their lamp connection, and there is not the smallest doubt but that, when the new machinery is installed, the town will be in possession of an extremely valuable asset, acquired—by chance—at half its cost price. It certainly seems that this additional outlay will mean working at a good profit, of which the ratepayers will reap the benefit, instead of having to "pay dearly for their luxury."

The Local Government Board inquiry regarding the loan (which is £5,450) for these extensions will be held at the Town Hall, Bray, on Wednesday, December 23rd, by Mr. L. E. H. Deane.

Bridgend.—When the electric lighting question was before the District Council last week, it was stated that they were waiting for a further communication from Mr. J. C. Howell, before they could do anything about applying for a provisional order.

Bulawayo.—At the meeting, on 14th inst., of the Bulawayo Waterworks Company, Limited, the chairman stated that the electric light, which is another department of this company, is progressing by this time. But for the rebellion, the arrangements for lighting the town would be completed. The machinery was ordered from the General Electric Lighting Company, of New York, and was sent out in the early part of the year. They had tried to get an increased allowance of time to complete the works from Dr. Jameson, in order that they might send out an electrical engineer to consider the best class of machinery for the work, but Dr. Jameson would not give that extra time, and therefore the whole plant was ordered from the General Electric Company. At the time of the outbreak that machinery was on its way for Mafeking, and that with the crushing machinery belonging to the Willoughby's Consolidated Company was stranded on the veldt; but it has been collected now, and is going up as rapidly as possible, and they hoped to have it erected by February or March. The General Electric Company sent out two men in charge of that machinery (Mr. Parham and Mr. Meakle), both excellent men, thoroughly conversant with their duties. Mr. Parham left during the rebellion, but Mr. Meakle, who has a thorough knowledge of electric work, is still there. This plant provides for 4,000 16-C.P. lamps. Now, the company had thought it advisable to have a resident engineer of its own to take charge of the waterworks and the electric light, and had been in communication with a gentleman who had been recommended by their consulting engineers, Messrs. Bramwell & Harris. They hoped to come to an arrangement with him, and that he would proceed to Bulawayo in a few weeks time to take entire control of the waterworks and the electric light.

Cardiff.—A failure in the private supply last Saturday caused considerable inconvenience. The *Western Mail* says it was due to a fire at the switchboard.

Tradesmen are making claims for compensation in consequence of the failure. The engineer reports that it is necessary to renew the switchboard as early as possible. The electrical engineer (Mr. Applebee), reports that at November 30th there were 12,909 8-C.P. lamps connected, as against 7,932 a year ago. The number connected during the month was 243 and those awaiting connection numbered 1,200.

The lighting of the new General Post Office at Cardiff has been entrusted to Messrs. J. B. Saunders & Co., of that town. Thirty-four Brockie-Pell arc lamps and nearly 600 incandescent lamps will be employed. Accommodation is being provided for conducting the majority of the telegraphic business at the new office, instead of at the Docks as at present.

Cheltenham.—The electrical engineer reports good progress made with the electric light extension buildings. Application is to be made to the Local Government Board for a £280 loan. The application of the Electric Lighting Extension Syndicate, Limited, re penny-in-the-slot machines, is not to be entertained. Alderman Norman stated at the last Council meeting that the Corporation had at present 135 customers for the electric light actually connected, and 11 waiting, representing an equivalent of 7,800 8-C.P. lamps connected, and 860 awaiting connection. He gave particulars of the financial position, and said he had the best reason for believing that at the end of the second year's working, in March next, there would be an actual balance above working expenses to put towards interest and repayment of loans.

Chester.—The ceremony of inaugurating the electric lighting works and switching on the current, was to be performed yesterday by the Mayor and Mayoress.

Colliery Lighting.—The Ocean Colliery, Nantymoel, now has a complete electric lighting installation. Pit-head, tips, screens, sidings, and offices, are all lighted by incandescent lamps.

Cromer.—There was a brief discussion at the last District Council meeting as to its position regarding electric lighting. It appears that the matter was dropped some time ago, when it was found that the cost of obtaining an order was £300.

Croydon.—The old parish church of St. John the Baptist is to be lighted electrically at the expense of Deputy Mayor Eldridge.

Dublin.—The Corporation has approved the estimates of the Electric Lighting Committee, which amount to £12,831. Alderman O'Reilly said the estimated income was £14,175. Alderman Pile stated that the estimated receipts were down as compared with last year, £1,200. They had struck out the £500 for depreciation formerly provided, and had substituted £2,500, which would go toward clearing off the principal of the cost of the machinery.

Exeter.—Residents having memorialised the City Council for a reduction from 6d. to 4d. per unit, for current, the matter has been referred to the Electric Lighting Committee.

Hampstead.—The electric light has been installed in Lyndhurst Road Church, Hampstead.

Harrogate.—The delay in completing the electric lighting works gave rise to discussion at the last Council meeting, and some strong comments were made as to the bad condition of the roads and footpaths. The engineer thinks the supply will be ready in February

Hove.—The Hove Electric Lighting Company will reduce the charge per unit for motive purposes to 3d., on and after January 1st. In regard to lighting, 8d. per unit will be charged for only one hour per day, instead of two, after the maximum number of lamps have been alight for the time, 4d. per unit will be charged.

Hull.—The extension scheme, which, as stated last week, was referred back to the Electric Light Committee a second time, and was also again confirmed by that Committee, who arranged with Mr. Robert Hammond to attend the meeting of the Council on 10th inst. to answer certain questions if desired. Mr. Hammond attended, and the matter was again gone into very fully. We are pleased to note that the result of the voting this time was the reverse of what it had been when the Council followed the lead of Dr. Holder. There were 36 votes in favour of the scheme and seven against, so that by a majority of 29 votes Mr. Barnard's scheme, as confirmed by Mr. Hammond, will now be put in hand.

Inverness.—We learn that the Council has instructed a committee to report upon the question of lighting the public streets and squares by electricity.

Ipswich.—By 17 votes to 5 the Town Council has confirmed its resolution applying for a provisional electric lighting order.

Lambeth.—A special report to the Vestry by the Clerk says that the Board of Trade had intimated that they would not sanction the transfer of the electric lighting order to a private individual, but would require a company to undertake the transfer. It had been arranged by the holders of the order that this should be done by a company known as the South London Electrical Supply Corporation, Limited. This company, which had been registered with a capital of £325,000, would not go to the public for subscription, the board having sanctioned £200,000 being underwritten. A notice of the registration appeared in our last issue.

Llandrindod Wells.—A few additional lamps beyond those already arranged for are to be included in the electric lighting installation.

Limehouse.—The District Board has resolved to support the application of the County of London and Brush Company for a provisional order.

Liverpool.—The Lighting Committee has approved of a scheme for the electric lighting of Church Street, Lord Street, Castle Street, Dale Street, James Street, Water Street, the Pier Head, and other thoroughfares. The scheme provides for the erection of 65 arc lamps, which will displace 152 gas lamps of various types.

London.—The matter of lighting the Edgware Road, which has been brought before the Marylebone Vestry by the Paddington Vestry, and to which we referred last week, was considered at Marylebone the other day. The Works Committee suggested that the Vestry were not prepared to entertain the proposition at present; but an amendment by Mr. Brook Hitching, referring the matter to the Electric Light Committee to consider the cost and report, was carried.

The St. Saviour's Board of Works is to inquire, through the General Purposes Committee, into the feasibility of substituting electricity for gas as a street illuminant in that district.

Lynton.—The question of the extensions of electric lighting is stated by the *Councillor* to be under consideration.

Newcastle.—The City Lighting Committee, on 14th inst., adopted a report containing the facts regarding the electric lighting in Edinburgh and the cost as compared with the same supply by private companies in Newcastle. The report is to be printed and issued to the Council.

Newington.—The meeting of the Vestry last week, when the Electric Lighting Committee's recommendation to oppose the application for a provisional order by the County of London and Brush Company was considered, was made the occasion for the exhibition of a good deal of ill-feeling; abuse was rampant, as were also proposals that members be expelled. However, after 4½ hours, the recommendation of the committee was adopted by 47 votes to 13, and a proposal that the Vestry itself apply for a provisional order was also carried.

Paignton.—Electric light was first introduced into Paignton some days ago by a business house.

Perth.—The Academy and School of Art at Perth has been altered and extended of late, and the premises are now lighted by means of 180 incandescent electric lamps, a small plant having been laid down by Messrs. Lowden Bros. for the purpose.

Peterborough. — Negotiations have been conducted between the Town Council and Messrs. Crompton & Co., Limited, for the sale of the provisional order and the premises purchased by the Corporation as an electric lighting station, have been continued. One of the company's representatives is to attend a Council meeting to discuss the matter.

Plymouth.—The electric light cables are to be at once laid in the Old Town Street and Ebrington Street, the cable having been obtained by the electrical engineer.

Radcliffe.—A sub-committee has been appointed with power to purchase a plot of land in Dale Street for an electric station site.

Stafford.—An application made to the Town Council by the Electric Lighting Extension Syndicate, Limited, is not to be entertained.

Thanet.—The Board of Guardians, after going into the question of lighting the Union buildings by electricity, have resolved to defer the matter for six months, and try incandescent gas.

The London School Board.—The London School Board last week refused to authorise an expenditure of £27 10s. for supplying the necessary installation and fittings required for the electric lighting of the rooms in the Hop Exchange, Borough, used by the superintendent of visitors and the correspondent for the Southwark division. A lively discussion took place as to the relative merits of electric lighting and incandescent gas. Mr. Riley stated that he had electric light in his own house since 1884, but grieved over the continual expense. Major Skinner, whose own palatial home is similarly lighted, said that he now greatly preferred incandescent gas. Mr. Barnes saw in the proposal the thin end of a wedge which would be employed in securing electric light for all their schools. Mr. Diggle made the humorous suggestion that the Board should apply to the landlord of the premises to bear the expense of the installation, a remark which impelled Mr. Stanley to observe that if Mr. Diggle would study for a new profession, he would learn that the fixtures would be known as the tenant's fixtures. The question of the healthiness of the electric light was, we suppose, ignored. The School Board spends extravagantly with one hand and niggardly holds back with the other £28, which might have been usefully spent.

Warrington.—The Town Clerk is making application for a provisional order for the Council.

Whitehaven.—Messrs. George Wilson & Co. are erecting electric light plant in the works of the Whitehaven Hematite Iron Company. The plant will supply current equal to 250 16-candle-power lamps.

Wolverhampton.—A recent failure of the electric light was attributed to an accident with the Art Gallery transformer. No damage was done, and there is stated to be no likelihood of a repetition of the occurrence.

Yarmouth.—The electric light undertaking during November earned £216 2s. 2d. to meet capital and sundry charges of £150 per month.

York.—The tenders sent in for the electric lighting installation have been submitted to Prof. Kennedy. It is understood that none of the firms have tendered for working the plant on a term of years.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Accident at Walsall.—A man named Spooner was killed on the South Staffordshire electric tramway line between Walsall and James Bridge on the 7th inst. His having been refused drink at a public-house it would seem he was the worse for liquor at the time, and a verdict of "accidental death" was returned.

Ashton.—The draft agreement between the Corporation and the British Electric Traction Company, Limited, relative to the supply of power to the Tramway Company, has been submitted to the Tramway Company's solicitor for approval.

Austria.—The Tramways Co. at Trieste proposes to substitute electric for horse traction on its lines.

Bristol.—Mr. Pearson, chairman of the Electrical Committee, on Thursday last week replied to the Tramway Company's final declaration that they would abandon the extensions by a notice to move at the next council meeting that a committee be appointed to consider the desirability of the Council acquiring the tramways of the company. The proposal is being supported by resolutions passed at various meetings in the town. This proposal is the immediate sequel to the abandonment by the company of their big scheme for electric tramways in all parts of the city. The purchase will, however, meet with a good deal of opposition in the Town Council, and it is understood that the Tramways Company will be hostile to the undertaking being transferred to the city.

At the Bristol County Court this week, James Jones, a carpenter, living in East Bristol, sued the Bristol Tramways Company to recover £40 damages for injuries sustained by his being jerked from an electric car on the Kingswood line. Judgment was given for the defendant company.

Cardiff-Penarth.—At Monday's meeting of the Cardiff County Council, the joint Parliamentary and Tramways Committee recommended that, inasmuch as the Corporation felt that they should keep in their own hands all their roads within the municipality available for tramways or other purposes, they could not consent to the application of the Penarth Tramways Syndicate (Limited) for a provisional order to construct tramways within the borough. The matter was, after discussion, referred back to the Committee for further consideration.

Cheltenham-Winchcombe. — This electric tramway scheme was considered at great length by the Cheltenham Town Council last week, who resolved upon certain amendments to the Bill. Prestbury Parish Council and a Winchcombe parish meeting also considered the scheme.

Dundalk.—At the meeting of the Town Commissioners on 8th inst. a communication was read from Messrs. V. B. Dillon and Co., solicitors to the syndicate formed to supply Dundalk with a system of electric tramways and lighting. A resolution was unanimously adopted signifying the consent of the commissioners to the application about to be made for powers to carry out these undertakings. The commissioners have taken steps to acquire a site for the generating station, a plot of ground adjoining the river embankment, with wharf frontage, &c. Local feeling appears to be in favour of both projects.

Motor Cars.—Before the New York Electrical Society last month, Mr. Joseph Sachs lectured on "Horseless Carriages." He referred to the history of the development of motor cars, and spoke on the questions of speed, weight, and construction. After dealing with steam and gas in connection with such vehicles, the electric motor was referred to. Mr. Sachs considered the advantages of the electric system were simplicity, ease of control, and facility of connection of power with driving wheels. The steering devices and brakes can be operated by electric power, and such a machine cannot be stalled. Since it is necessary to depend upon the storage battery for supply of power, the disadvantages of the electric system were the great weight of the battery, the limited supply of energy, the mechanical disintegration of the plates and the lack of facilities for charging the batteries. The horseless carriage service, the speaker stated, was harder on storage batteries than traction work. He thought that a vehicle *par excellence* would be one combining the electric system with an outside source of supply. A dynamo operated by a gas motor, *à la* Heilmann locomotive, would probably produce effective results. With all its disadvantages, however, the electric vehicle was superior to either of the other types.

Russia.—The municipal authorities of Cronstadt have just decided on the construction of an electric tramway in the town.

Aberdeen and Motor Cars.—A deputation from the Aberdeen Town Council is to visit "London or some of the other places" where motor cars are to be seen in operation for the purpose of obtaining information as to the establishment of a motor-car service to the bathing station. We would recommend the Council to wait awhile. In six months' time they may be able to see something worth coming for.

Sheffield.—Sheffield City Council have refused, says *Daily Tenders and Contracts*, the offer of the Mechanical Traction Syndicate to lease the tramways at a rental of £30,000 a year.

Stoke.—A proposal of the New General Traction Company to lay an electric tramway on the Stoke portion of the Binley Road, has been supported by the Stoke Parish Council on conditions that the company carry the wires on brackets. A committee is also to inquire further into the matter.

Stockton.—A committee has been appointed to confer with other local authorities as to the question of the reconstruction of the tramways in Norton, and their working by electricity or otherwise.

The City and South London Railway.—We understand from the *City Press* that this company has not yet commenced work beneath the church of St. Mary Woolnoth, but expert opinion has been taken upon the possibility of making the station without endangering the church, and it is stated that, from an engineering point of view, the project is quite feasible.

Yarmouth.—The Council had the proposals of the British Thomson-Houston Co. regarding their tramway scheme before it the other day. The route suggested was not approved of by several members, and ultimately it was referred back to the Lands Committee.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

CABLES.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
Puerto Plata-Martinique ...	Dec. 19th, 1895 ...	...
Amazon Company's cable Parintins-Itacatiara.	May 5th, 1896 ...	...
Obidos-Parintins	Dec. 7th, 1896 ...	...
Pará-Maranham	Oct. 8th, 1896 ...	...
Maranham-Ceará	Dec. 2nd, 1896 ...	...
St. Lucia-St. Vincent ...	Nov. 30th, 1896 ...	Dec. 14th, 1896.
St. Croix-Trinidad	Nov. 30th, 1896 ...	...
Suakim-Dejdda	Dec. 5th, 1896 ...	
LANDLINES.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Salisbury-Umtali	July 11th, 1896 ...	...

December 5th, 1896.—Katarina-Larissa route working badly.

A New Industry in the West Indies.—Under the heading of the West Indies and the Sugar Trade the *Standard* publishes this week the following letter. Mr. Warren's long experience as chemist in the Silvertown Works, where Indiarubber is very extensively used, renders his opinion of much value, :—"I have no hesitation in saying that the West India Islands are well situated, geographically, for the cultivation of Indiarubber, of good quality, and, looking at the fact that our supply is diminishing, I think that our Government may assist the West India planter with seeds or saplings of different varieties or species, to find out what plant will be best suited for the soil and climatic conditions, and, what is of equal importance, what plants can be depended on to yield a profitable product as soon after planting as possible. Arborescent plants, as a rule, yield better qualities of rubber, but, of course, must stand a few years before being tapped; vines and creepers reach maturity sooner for yielding, and although the quality is inferior, it is far more encouraging to a planter to obtain a commercial status for his product than to place the whole of his venture on more ambitious hopes. It is not unreasonable to try plantations of plants yielding Indiarubber quite equal in quality to what we get from Central America, or even Brazil. An inspection of the map will show that they are in the same physical zone, and, being so near to the American coasts, there is a fair prospect of success; but, of course, a few years will be required before a tree can be freely tapped.

THOS. T. P. BRUCE WARREN.
Indiarubber, Guttapercha, and Telegraph Company,
Silvertown, E., *December 14th.*

Those interested in the plantation of Indiarubber will find a full account of the "Cultivation of Indiarubber in Assam" in the *Kew Bulletin* for September and October, where information is given concerning experiments now being carried out by the Indian Government.

Brighton and Overhead Wires.—At the Brighton Police Court last week the arbitration case between the Postmaster-General and the Brighton Corporation, with regard to the proposed erection of poles along the Ditchling Road for the support of an overhead trunk line of telephonic communication between London and Brighton, was heard before the Stipendiary Magistrate (Mr. C. G. Heathcote).

Canadian Telegraphs.—The Canadian Government electricians are, says a contemporary, to have a busy time of it next year. The line of telegraph along the north shore of the St. Lawrence is to be extended to Belle Isle. This is an important work in connection with the navigation of the St. Lawrence, and also in regard to the fisheries, and the Canadian Government are to be congratulated on having decided to carry it out without delay.

Fife Telephones.—The Fife County Road Board has had before it a scheme for erecting a private telephone system for police purposes over the county. Various offers for the work had been sent in. One by a London firm estimated at £1,900, while Messrs. James Pollock, of Glasgow, quoted £1,955 to include six months supervision after erection. It was resolved to ask the County Council to sanction an expenditure of not more than £2,000.

Reduction of Telegraph Rates to India and the East. For some considerable time we have had to call attention to the high tariff for telegrams to India and the East. In a recent issue of *Commerce* we find it stated that it is now proposed to make some reduction in these rates. We are glad to find that the rates *viâ* Suez and Aden to the Seychelles are to be reduced from 7s. 3d. to 5s., and to Mauritius the reduction will be from 8s. 9d. to 5s. This is a laudable step, but we see that the reduction is only to take place from January 1st next. In view of the fact that on July 1st last a considerable reduction was made to Madagascar, in accordance with an agreement entered into between the French Government and the Eastern, and Eastern and South African Telegraph Companies, it would create a more favourable impression were the English companies concerned to take the reduction of rates to Mauritius and the Seychelles as dating from July 1st last, and to refund to the senders the excess which they have paid since that date, beyond the amount of the proposed reduced rates. It is to be regretted that no reduction is yet announced in the rate to India, but doubtless this will follow under the pressure which we understand is now being put on those concerned.

Report of the Post and Telegraph Department of Queensland for 1895.—The number of telegraph stations open at the end of 1895 was 366; the miles of line 9,979; and the miles of wire 17,790. The number of messages transmitted and received (including international) was 1,055,615. The value of ordinary messages transmitted (excluding O.H.M.S., value £8,718 11s. 7d.) £71,000 5s. 9d. Revenue paid to Treasury (including £4,976 11s. 5d. on account of telephones) £76,011 4s. 7d. (an increase of £3,852 over 1894). Cost of construction to date (including buildings) £846,670 2s. 1d. As regards telephones, during the year ended June 30th, 1896, 65 subscribers were added and 26 disconnected, making a total at date of 600 on the Brisbane Exchange. The number of calls average 5,500 per day and 100 per night. There are 10 public call stations in Brisbane, the receipts from which have been £59 3s. 6d. The system, it is stated, cannot be said to have given unmixed satisfaction, although an improvement has been observed since this department took the more complete repairs of subscribers' instruments in hand. The faults are still numerous, and for the 12 months ending June 30th, 1896, have amounted to 2,858 instrument faults, and 661 line faults. The former serious state of affairs is undoubtedly due to the fact that subscribers purchase indifferent instruments and use them carelessly. It may here be noted that in the 600 instruments in use on the system there are 12 distinct types, each of which have variations in parts. Such a state of things militates strongly against the successful working of the system. The line faults are composed of crosses, earths, disconnections, &c., mainly caused by the extremely crowded state of the poles in the city. The New Caledonia Cable has continued to work satisfactorily, but the revenue has not been sufficient to provide for any reduction of the amount of subsidy payable by Queensland.

The American Pacific Cable Scheme.—Last Monday's *Financial News* contained the following editorial note:—The capitalists composing the American Pacific Cable enterprise having been baulked in their endeavour to secure a monopoly from the Hawaiian Government for their scheme, the way would seem to be now clear for our own Government to carry out the project of an inter-colonial cable from British Columbia to Australia *viâ* the Hawaiian Islands, which form the only available intermediate resting point. The line originally proposed by the company, which includes such magnates as D. O. Mills, Ex-Mayor Hewitt, of New York, and J. J. Hill, of the Great Northern Railway, was a cable between the United States and Hawaii, and a concession was granted for its construction. But a new contract for an extension of the cable to Japan and Australia was sought by the promoters, who wanted two years to obtain concessions, both from the Japanese and Australian authorities as well, so that a threefold monopoly could be secured. The company offered as an inducement to purchase $375,000 of the new four per cent. Hawaiian bonds, and to put up a forfeit of $125,000 should an inter-island cable not be constructed within a year. If the concessions from the other Governments were obtained a further sum of $125,000 was to be forfeited in the event of the whole undertaking not being carried out within three years. A twenty years exclusive franchise was the consideration sought; but President Dole's administration, in keeping with the sentiment of the community, wisely rejected the proposals; so that the company can now work only on the original lines for a line from the United States to Honolulu. The Pacific Cable Conference, we opine, will not be slow to appreciate the advantages gained by the check which the American company has thus met with.

Telegraphs in British North Borneo.—At a recent meeting of one of the telegraph companies the chairman said "that when they met in July last it was foreshadowed that the telegraph line across their territory would be completed in a short time. As a matter of fact the junction between the two opposite working parties—one working from Labuan and the other from Sandakan—took place on August 3rd, less than a month afterwards. As to the cost, it was then mentioned that £8,458 had been expended up to the end of 1895, and that an additional outlay of about £2,000 would be required for its completion. The total expenditure up to the time of joining the two sections was £10,514, so that both predictions had been practically verified. For some reason or other, which they had not yet been able to get to the bottom of, they had not at this moment a through telegraphic communication from Sandakan. They knew that from the centre of the country to the coast, the line, with the exception of one breakdown, had been in daily use, but why they had not through communication he was unable to say."

The Telegraph Wire Export Trade.—Rather a quieter tone prevailed in the export trade of this country during last month in telegraph wire and apparatus connected therewith, the value of the shipments being returned at only £48,371, as compared with £162,054 in October last, and £70,459 in November, 1895. The returns for the 11 months ending with November last, while being a long way behind 1894, show a large increase over 1895, the exports having attained an aggregate value of £748,276 as compared with £493,665 in the corresponding period of last year, and £1,376,294 in the first 11 months of 1894.

Telegraph Rates to the West Indies.—The reduction of rates to the West Indies have been secured at last by the aid of American and French enterprise, backed up by active and substantial co-operation of the French Government. Jamaica alone remains out in the cold. The effect of the relief got to our colonies at last by the above-mentioned people will be to secure to them the great bulk of the business of the colonies which by their energy and push they have secured.

The Iceland Cable.—The scheme for the establishment of a submarine telegraph cable between Scotland and Iceland *vid* the Shetland and Faroe Islands, to which we referred last week, has made progress, for we hear that Mr. Mitchell, a barrister, and Mr. Thordall, an Icelandic merchant, of London, representing an English telegraph company which is acting in connection with influential Icelanders, and M. Haldorsson, a merchant, of Iceland, have arrived at Copenhagen, in order to enter into negotiations with the Danish Government concerning the scheme.

CONTRACTS OPEN AND CLOSED.

OPEN.

Christiania.—January 7th. Tenders are invited by the Director of the Norwegian State Railways for the delivery of about 4,280 tons of steel rails with the accompanying fish plates. Further particulars may be seen at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m.

France.—January 31st. Tenders are being invited until January 31st next, for the contract for an installation of electric lighting in the Asile d'Aliénés at Saint Jvon (Seine Inférieure).

Harrogate.—January 1st, 1897. The Council wants tenders for wiring the Municipal Offices, Victoria Baths, Market Hall and Public Library, also for electrical fittings for the same.

CLOSED.

Ayr.—Mr. Hammond recently reported on the tenders received for the proposed extensions in the generating plant, and the committee recommended the Commissioners to accept the tenders of Messrs. Siemens Bros. & Co., Limited, for sections A and B, amounting to £2,130 and £4,887 respectively, and the tender of Messrs. John Fowler & Co., Leeds, Limited, for section D, amounting to £645 15s. The acceptance of Messrs. Callender's tender both for the high and low tension cables, on condition that the period of guarantee be extended from three to five years was also recommended. The Council adopted these recommendations after an attempt had been made to pass a resolution to put in two low-speed engines. The voting was rather close (9 to 7).

Portsmouth.—At a meeting of the Town Council on Tuesday, the Electric Light Committee submitted a report recommending that the joint tender of Messrs. Yates & Thom and S. Z. de Ferranti, Limited, be accepted, subject to a deduction of 5 per cent. off the sum quoted for the engine, which had been agreed to, also that a joint contract be entered into by those firms for the supply of the whole of the plant. The amount of the tender, after allowing for the deduction, was £8,448 17s. 6d. Alderman Ellis, Chairman of the Committee, in moving the adoption of the report, spoke of the difficulty under which the electric light was being at present produced owing to the want of the new plant. The recommendation was adopted.

Cheltenham.—Eight tenders were sent in to the Council for a cast-iron tank for the electric light station and that of Messrs. Newton, Chambers & Co. at £84 10s. was accepted.

Todmorden (Yorks).—The tender of Mr. R. Blackburn for electric bell installation for the Workhouse has been accepted by the Board of Guardians.

NOTES.

To Our Readers.—Next week being Christmastide, we shall publish on the Thursday morning instead of Friday, therefore it is essential that all matter for insertion in that issue should be here by Tuesday morning at the very latest. Advertisers will also please note that we go to press earlier.

The Jacques Carbon Generator.—In an article on "Electricity Direct from Coal," in the current number of *Harper's Magazine*, Dr. Jacques describes his new carbon generator. Notwithstanding the experiments of Reed and others (*see* Electrical Review, September 18th, 1896,) Dr. Jacques still maintains that the action of his battery is not thermo-electric; this, he says, being proved by the fact that when the whole apparatus was enclosed so as to keep all parts at a uniform temperature, the maximum electromotive force was obtained. But, surely, the cold air injected must have a cooling effect on one of the surfaces of contact? Dr. Jacques, we are glad to see, has carried out our suggestion of making a test in which the carbon burnt outside the pot is measured. This turns out to be more than the carbon consumed inside the pot, *i.e.*, 40 per cent. was consumed inside, and 60 per cent. outside. This reduces the estimated efficiency of the generator from 82 per cent. to 32 per cent.—a result which would appear to indicate that the fuel used in heating the apparatus has more to do with the generation of the electricity than what is consumed inside. But even 32 per cent. is a remarkably high electrical efficiency compared with the steam engine and dynamo, and we are, therefore, surprised to read in Dr. Jacques' article: "contrary to some statements that I have read, I believe it will be some time yet before the dynamo is relegated to the attic with the spinning wheel, or the wheels of the steam engine cease to revolve." It is only fair to say that this want of faith in the speedy development of his generator is owing to difficulties that have been met with in the details of practical working. Much stronger evidence, however, will be required before we can admit that even under perfect working conditions it is possible to convert a third of the energy of fuel into electricity. Even if this be true, it is highly improbable, in view of Reed's experiments, that the energy is due to electrolytic combustion of carbon.

A 2,500-Volt Shock.—Dr. W. S. Hedley in the *Lancet*, December 5th, 1896, gives the details of a recent electrical accident. An electrical engineer while standing on a chair ready to move a reversing switch on the arc lamp side of a rectifier, accidentally short-circuited the light leads through his body from hand to hand, the D.P. being found afterwards on measurement to be about 2,500 volts:—

> He says that the first thing he realised was that he found himself standing on the floor, but has no clear idea as to whether he jumped off or was "knocked off." The forearm was "drawn up close to the chest" and the hands clenched. From a little above the elbow downwards he described a "feeling of pulsation" and a violent beating in exact step with the alternators (running 83 periods per second). All power of movement below the elbow was absolutely lost, but the arm at the shoulder could be moved from the side. The pulsations, although still retaining their periodicity, soon became less violent, and motor power returned successively in the muscles that move the elbow, wrist and fingers. In three minutes he felt "none the worse." There was no sensation of burning at the moment, but 10 minutes afterwards the hands became painful, and examination showed a burn on the tip of the middle and ring fingers and on the back of the little and ring fingers, with a seared line across the lower portion of the palm. There has been no other effect, excepting that he expresses himself as feeling "decidedly better in general health."

Dr. Hedley estimates the resistance of the body under the given conditions as 10,000 ohms; consequently the current which passed through must have been about 250 milliamperes, but this estimate is necessarily mere guesswork. The violent beating in exact step with the alternators has frequently been recorded in similar cases of electric shock.

Efficiency of Boiler Grates.—In order to determine the best rate of coal consumption per square foot of grate, Mr. Christie, who places his results before the American Society of Mechanical Engineers, took 108 tests and plotted on two diagrams as abscissæ the pounds of coal per square foot of grate and as ordinates—the consumption of coal per horse-power on one diagram and the consumption of combustible on the other. What he calls the mean line drawn through the points of the diagrams, inclines in both diagrams to the 13 mark on the line of abscissæ. Hence he determines 13 as a most economical rate of burning anthracite coal per square foot per hour, and he states that for bituminous coal the same method would give a combustion rate of 23·8 lbs. The results, so far as they are reliable, seem to point to the very much larger grate area necessary with anthracite coal. The "horse-power" is understood to be 34½ lbs., evaporated from and at 212°. Would it not be as well to drop that ambiguous and misleading term of horse-power when discussing boilers? If there must be a unit of evaporation, let it be called anything but a horse-power. Why not use an evaporation of 10 lbs. of water as a unit of evaporation? It is what can be evaporated under good conditions by 1 lb. of coal, and it is the weight of a gallon of water.

Incandescent Street Lighting.—The experience of Denver, Col., in street lighting by incandescent electric lamps, is summarised in the New York *Electrical Engineer* by Mr. J. H. Poole, the general manager of the Denver Consolidated Electric Co. The "Edison municipal system" was originally employed, 1,200 lamps being used. In time these incandescents were replaced by arcs, because the public were far better satisfied with the latter. The Company in consequence lost a hundred-thousand dollars. This was due in part to the continual changes and rearrangements of lines necessitated, and to the ultimate loss of all the machinery, wire, posts, and fixtures. There are now, says Mr. Poole, arc lights suspended from the intersection of streets, and they seem to give general satisfaction. He concludes by saying, without hesitation, that the preference of the people in Denver is decidedly for arc lights. Our contemporary says this information will be interesting data for St. Louis where it is proposed to substitute incandescents for arcs on the streets.

The Progress of Engineering.—Mr. Wolfe Barry, C.B., gave some interesting statistics in his presidential address to the Institution of Civil Engineers, of the progress made by engineering during the present reign. These statistics, as given in the following table, indicate an extraordinary development in the agencies for distributing goods, and for the rapid transit of passengers, and a corresponding increase in the consumption per head of staple products:—

	1837.	1896.
Population of kingdom	26 millions	39 millions
Miles of railways ...	1,000	21,000
Capital of railways ...	30 millions	1,000 millions
Speed of express trains	43 miles (1847)	60
Passengers	23½ millions (1843)	1,000 millions
Goods receipts	1½ " "	44 millions
Commercial navy of British Empire (steamers)	70,000 tons	6½ million tons
Total ...	2,333,000 "	10½ "
Tonnage of imports and exports	140 million	700 million
Coal mined (tons) ...	65 "	200 "
" per inhabitant ...	2·34 tons	4·73 tons
Pig iron made (tons) ...	3 million	7½ million
" per inhabitant	·1 ton	·2 ton
Submarine cables ...	...	162,000 miles
Death rate in London ...	24·4	19·5

The remarkable decrease in the death rate of London is no doubt partly due to improved sanitation, but probably also, in part, due to greater facilities for introducing fresh blood afforded by the improved means of transit. It is appalling to think where we shall be, at this rate of progress, in another 60 years. The check is likely to come, in the first place, from the exhaustion of our coal supply, which, as Dr. Hopkinson has recently pointed out, may be earlier than is usually supposed. Already the P. and O. steamers coal at Colombo with Australian coal; a small rise in the price of English coal would bring Australian coal to Aden, from which the steps are few to the home markets. Such pessimistic reflections may prove a valuable antidote to excessive jubilation over our great material progress.

Inclosed Arc Lamps.—A new arc lamp on the inclosed method has been introduced by the Diehl Manufacturing Company, of America, it being the invention of Mr. John Knight. The feature of the Knight lamp is the method of clamping the globe, which does away with the cumbersome side castings or rods, thereby eliminating the usual shadow, and the construction is such that any ordinary straight lamp chimney, or such as is commonly used with an argand burner, may be substituted in case of breaking, thus relieving the user of the necessity of keeping a supply of specially made globes. Our trans-Atlantic namesake gives a number of photos of the Knight lamps, including some recent types of the series lamp, which are made with a striking magnet. This auxiliary magnet is stated to not only prevent the chattering of the carbons, but insures the striking of the full arc when the lamp is first turned on. These series lamps consume 4 to 10 amperes at a pressure of 45 volts, and are connected two in series on a 115-volt circuit and four in series on a 230-volt circuit.

The Modern Version of Supply and Demand.—Prof. Thurston, in the pages of *Science*, discredits the generally received idea that increased demand implies increased prices, and that an increased supply causes lower prices. This is not the case. It may be the case momentarily, but, in the long run, "increased demand and an enlarged market, by permitting more economical operation of the system of production, decrease prices." He instances the copper production of the Lake Superior mine. In operation for years, it has been in competition with such mines as the Calumet and Hecla, and has yielded almost uniform profits all the time. The cost of production has been reduced to one-half what it was a generation ago, and the value of labour has been correspondingly reduced per ton of product, and the market price of labour has gone up. In the open market, the price of a commodity is practically the cost of production plus a fair business profit. If this result is not obtained, a business languishes or expires. If profits are abnormally large, capital is attracted and competition set up, and the availability of capital now brings about the modern fact that increased demand causes reduced prices.

The Bristol Tramway.—In our correspondent's statement as to Bristol, printed on page 763 of our last issue, the statement was therein made that it was suggested the opinion of Lord Kelvin and Dr. Hopkinson as to Mr. Parshall's report was expressed in "very guarded terms." A printed copy of the report in question, and of the confirmatory letters of Dr. Hopkinson and Lord Kelvin, has been sent to us, from which it appears the confirmation of the conclusions reached is not so indefinite, so we publish these letters with Mr. Parshall's report. In endeavouring to make arrangements for the supply of current to tramway undertakings, municipal authorities ought to be imbued with the desire to do what is fair and reasonable. At the present moment we learn of a tramway enterprise in which the proposed line is in part under the supervision of a corporation which has large (too large) gas works. The promoters have had the greatest possible trouble to prevent a stipulation that, if powers be granted, the dynamos should be operated by gas engines, using the corporation's product and erected in the corporation's station, which happens to be at the most inadvisable place for the working of the line.

The Use of Drawings.—*Cassier's Magazine* draws attention to the curious fact that many good workmen with years of shop experience seem to be afraid of drawings. If they had a model before them instead of a drawing they could turn out their work more easily. Our contemporary questions whether it would not pay to give more attention to making drawings plain and to teaching the men to read them. Shading of parts and increasing the pictorial effect in general, so as to make one piece stand away from another, would seem to be a good thing, and in this respect some of the older forms of shop drawings might well be taken as examples worth following. To-day many of these out-of-date drawings are considered as having been wasteful of drawing office time, and uselessly elaborate, and yet they had good points. They told their story in a way quite foreign to the modern blue print.

Telephone Relays.—In a short series of articles on "Telephone Relays," which have recently appeared in the *Electrical World* (America), and which have just been concluded, Mr. P. D. Lockwood has sketched the whole history of the subject, and has given an excellent analysis of the theory of the matter. His general conclusions agree entirely with what we said in the leaderette in our last issue, he says, "with our present knowledge, I see no place for the telephone repeater as a means for accomplishing the telephonic transmission of conversation over lines too long to be operated otherwise;" also, "we can scarcely expect the repeater to speak to its transmitting diaphragm as loudly as the operator speaks to the initial transmitter; and if it doesn't, it is obvious that the voice currents in the receiving line will not be as strong as those in the transmitting line, and that the loudness of the speech reproduced will not be increased or even maintained." Obvious as this is, and clearly as Mr. Lockwood has put it, we are afraid that many inventors will still go working on at the subject in the usual blind and unsystematic fashion, quite oblivious of the irresistible logic of facts.

The Royal Institution Lectures.—The official list of the Royal Institution meetings and lectures is now issued. We select the following as being of interest to electrical men:—

Friday, January 22nd.—Prof. Dewar, on "The Properties of Liquid Oxygen."

Friday, February 5th.—Prof. J. Chunder Bose, on "The Polarisation of the Electric Ray."

Friday, April 2nd.—Mr. C. T. Heycock, M.A., F.R.S., on "Metallic Alloys, and the Theory of Solution."

Friday, April 9th.—Lecture by Lord Rayleigh; subject not yet announced.

Christmas Lectures by Prof. Silvanus P. Thompson. A course of six afternoon lectures on December 29th and 31st, 1896, and January 2nd, 5th, 7th, and 9th, 1897; the subject being "Light: Visible and Invisible." The Professor will deal with the subject under the following heads:—(1) Lights and shadows; (2) The visible spectrum and the eye; (3) Polarisation of light; (4) The invisible spectrum (ultra-violet part); (5) The invisible spectrum (infra-red part); (6) Röntgen light.

Tuesdays, January 19th, 26th, February 2nd, 9th, 16th, 23rd, March 2nd, 9th, 16th, 23rd, 30th, and April 6th, Prof. Augustus D. Waller, M.D., F.R.S., will deliver a course of 12 lectures on "Animal Electricity."

Saturdays, March 6th, 13th, 20th, and 27th, and April 3rd and 10th, Lord Rayleigh will deliver a course of six lectures on "Electricity and Electrical Vibrations."

Measuring the E.M.F. of Batteries.—In a long letter to the *Electrical World* (American), of November 28th, Mr. J. F. Cosgrove, of the Chicago School of Electricity, points out an error which was made in our article of September 4th, on "A New Method of Measuring the E.M.F. of Batteries," the batteries having in the figure been shown in opposition instead of in series. The major portion of the letter is, however, devoted to a (so-called) improvement on the method, the writer describing at length an arrangement which he evidently believes to be new, but which is nothing more nor less than Lumsden's or Lacoine's well-known method.

Charge of Fraud.—Samuel Fynn, who has been before the Thames Police Court on several occasions on a charge of obtaining money by false pretences, has been committed for trial, bail being allowed. Among evidence given last week was that of Mr. Charles Tijon, High Bailiff of Bow County Court, who proved that 25 executions and arrests for debt had been issued against the accused since 1892; four bills of sale for £30 each had been executed since 1893 on his plant and furniture, and during the past five years the parish authorities had to distrain for rates about twice each year.

X Rays and Asthma.—During the past year X rays have been associated in print with almost everything under the sun. A New York contemporary now says that among recent discoveries made by means of the Röntgen rays is the observation in cases of asthma that the right half of the diaphragm stops working during the attack, and the left half is compelled to bear all the exertion.

Firefly Rays.—H. Muraoko, of Japan, describes in *Wied. Ann.*, Vol. 59, p. 773, some remarkable experiments he has made on the rays emitted by the firefly. In his first experiment, he took plates of equal thickness of copper, aluminium, zinc, and brass. Each of these plates was laid on a piece of cardboard with a cruciform aperture, and the cardboard was then laid on the sensitive film of a photographic plate. The whole was then wrapped in three or four folds of black paper, and laid in the bottom of a flat box. The box was then filled with about 300 fireflies, and left exposed to their radiation for two nights. The result was quite contrary to expectation. After development and fixing, the parts of the plate under the cruciform openings were found to be unaffected by the rays, while the rest of the plate under the cardboard was completely blackened. An experiment was then made which showed that contact electricity generated between the cardboard and the metal plates had nothing to do with the effect. When the metal plate was removed, an exposure to the firefly rays gave a blackened cross, and only a slight effect under the cardboard. When the metal plate was placed next the photographic film, and the perforated cardboard above the metal, the photographic action was uniform all over the plate. The cardboard seemed to act towards these rays as a piece of soft iron acts towards the magnetic lines of force. The direct light of the firefly acted on the plate like ordinary light. Muraoko concludes from these and other experiments which he has made, that the firefly light acquires properties analogous to those of the Röntgen rays by filtration through black paper or cardboard, and thinks that these rays, like the Becquerel rays, are intermediate between the Röntgen rays and the ultra-violet. The filtered firefly rays can be reflected. Refraction, interference, and polarisation have not yet been proved; but Muraoko feels convinced that they exist.

The Telephone Superseded.—This is the title of a note which appears in the *Photographic News*, and which refers to an article in *Pearson's Magazine*, entitled, "An Electric Eye," an invention of Mr. Jagadis Chunder Bose for signalling without wires by Hertzian waves. "Probably," says the *Photographic News*, "in the near future, the hideous network of wires which now can be seen above our big cities will be done away with, and the invisible Hertzian waves will do all we want." Of course, the *News* sees clearly how the separate communications sent from numerous transmitters are to be received only on the corresponding individual receivers. No doubt "specially tuned receivers" will be used, this is such an obviously simple and practical solution of the difficulty, and quite easily carried out!

Alternating Arcs.—The question was recently raised by the New York *Electrical Engineer* whether the number of alternating arc lamps in use is not increasing. The largest electrical company in the States has now written to our contemporary, stating that a very large number of alternating current arc lamps were sold in 1896, and the number will probably be doubled in 1897. The company referred to therefore concurs with our contemporary in the belief that the alternating arc lamp is making great strides, although it is difficult to say yet that relatively it is overtaking the direct current arc lamps.

Prison Lighting.—A lot of "stuff" has been appearing in the newspaper press this week regarding the announcement that the lighting of certain of the London prisons by electricity is under consideration. It is stated that a special form of treadwheel is to be designed to supply the motive power. The idea of a criminal "throwing brightness on dark places" as he does hard labour on the treadwheel has taken the newspaper man's fancy.

How They Do It in the States.—An exchange says that there have been troubles of late in the Warwick Electric Company at Wellington, O., which operates a plant. A college student, when arrested, made a confession that he and others had destroyed machines belonging to the system for lighting the city, and had stolen workmen's tools. It is said he was induced to do this by disgruntled stockholders, who wished to impede the receiver of the plant in the discharge of his duties.

Obituary.—We regret to hear that Mr. Francis Harwood, engineer, a respected member of the English colony at Lisbon, where he had been chief of the Eastern Submarine Telegraph Company's station for the past 26 years, died in that city on the 4th inst. Mr. Harwood was a Commandator of the Portuguese Order of Christ.

Mr. John Galloway, Vice-Chairman of Messrs. Galloway and Co., Limited, engineers and boiler makers, Manchester, died on Wednesday at Old Trafford.

The Institution of Junior Engineers.—On Saturday, December 19th, at 3 p.m., the members will visit the Deptford station of the London Electric Supply Corporation.

Explosion.—On Saturday last, at Berlin, Herr Isaak was conducting experiments with what is supposed to be acetylene, when an explosion occurred, which resulted in the death of himself and three assistants. The cause of the accident has not been, and probably never will be, discovered. It seems likely, however, says the *Standard*, that Herr Isaak was not sufficiently aware of the dangerous qualities of acetylene, for he told his acquaintances that he had liquefied it and mixed it with air in the proportion of one to twelve—two operations which could not fail greatly to enhance its explosive character.

Disclaimer.—The following letter came to hand from Messrs. J. D. F. Andrews & Co., too late for our "Correspondence" columns:—"With reference to the recent action between Andrews & Co. and Ullathorne, I have received expressions of condolence on the result of that action, and I would esteem it a favour if you would permit me through the medium of your columns to state that neither myself, nor my firm of J. D. F. Andrews & Co., had any connection with the transactions dealt with in the action from beginning to end.

The Decadence of the Manhattan Railroad.—Up to the year 1893, the number of passengers using the New York elevated railroads steadily increased, and that year saw the immense number of 219,621,017. The following year saw a drop of over 23,000,000, and the present year, the financial year ending September 30th, the number has dropped to some 183,000,000, or, if we recollect rightly, about the figure only reached on the upward direction in 1888. The New York *Electrical Engineer* says that in the meantime the city has increased in area, wealth, and population, and, generally, in all the factors tending to foster travel. Why, then, this serious decadence? It is not suggested that the financial unrest may have done something, but that the line has not kept up with the times. It is still "experimenting" with electricity and air. Why, at this date, should experiment be needed, is very sensibly asked? Can it be possible that the directors are looking to the Metropolitan of London for light and leading? Our contemporary points to the successful overhead lines of Liverpool, Chicago, the underground electric roads of London and Buda Pesth, and some 1,500 trolley lines the world over, as convincing proof to any except the Gould-Sage ring of the success of electric working. A brisker, brighter, and better service is demanded, and one would suppose, with the unrivalled facilities of New York, that the company would really endeavour to cope with the traffic that offers. The conclusion is drawn that the necessity for an underground electric line is daily more obvious.

Warning.—The Assistant-Commissioner of Police repeats the warning to householders not to allow men to enter their premises under the pretence of inspecting electric light wires. Since the previous notice was issued a further number of larcenies have occurred in London through this being done.

In Memoriam.—A handsome stained glass window, in memory of the late Sir James Anderson, is one of the features of the new chancel that has been erected at the Parish Church of Dumfries, his native town. It has been presented by his son, Mr. Kenneth Anderson.

Researches on Polarisation.—A short time ago we had occasion to notice a paper by Rudolph Ihle in the *Zeitschrift für Physikalische Chemie*, on the catalytic action of nitrous acid, and the potential of nitric acid. In a Grove's cell it was found that nitrous acid lowers the potential, and that its effect is a logarithmic function of its concentration. Ihle found the potential of nitrous acid to be lower than that of nitric acid. This paper may be found in the *Zeitschrift für Physikalische Chemie*, 1896, Vol. 19, p. 577. In considering, however, the action of nitrous acid in a Grove element, another paper by the same author should be referred to. It is to be found in the *Chemiker Centralblatt*, 1895, Vol 2, p. 428, and also in the *Zeitschrift für Electro-Chemie*, p. 104. Ihle found that if the nitric acid in Grove's element is gradually diluted with water, the electromotive force remains nearly constant until the acid contains 38 per cent. of nitric acid; on further dilution, the E.M.F. falls from 1·8 to 0·7 volt, and with 28 per cent. of nitric acid has the smaller potential. If, however, potassium nitrate is added to the 28 per cent. acid, the potential rises from 0·7 to 1·8 volt, but falls again to 0·7 as soon as the nitrous acid is destroyed by potassium permanganate, hydrogen peroxide, carbamide, &c. Similarly, the potential of a 38 per cent. acid is lowered by the addition of potassium permanganate or of carbamide. It therefore follows that nitrous acid is the real depolariser in a Grove's element. Whilst noticing this subject, we should not pass by a paper by Franz Streintz, in the *Annalen der Physik und Chemie*, 1896, series 2, Vol. 57, p. 711. He describes some researches which he has been conducting upon the polarisation and resistance of a galvanic cell. He has found that in any closed circuit containing a galvanic cell and a voltameter, it is impossible to obtain any method for determining the polarisation during the course of electrolysis. For, as the author shows, not only is the electromotive source a function of the strength of the current, but the resistance also changes with this, or, rather, with the density of the current on the electrodes.

Lectures.—Mr. W. H. Preece lectured to a large audience at Toynbee Hall last Saturday night, on "Telegraphy Without Wires." In the course of his remarks he referred to Marconi's invention.

At the Corn Exchange, Lewes, Mr. A. H. Fison, D.Sc., delivered the first of a course of lectures on "Electricity and Magnetism," the other day. His subject was the "Induction Coil."

Prof. M'Kendrick, on 7th inst., addressed the Edinburgh Royal Society on the "Electric Stimulation of the Nerves."

On Friday last Mr. E. A. Bayles gave the last of a course of lectures on "Electricity," in the dining-room at the Telegraph Manufacturing Company's Works, at Helsby. The subject was "Electrolysis and Electricity as Used for Explosive Purposes."

The other day a lecture was delivered by Mr. Robert Macdonald, M.A., B.Sc., on "Electricity and its Various Appliances," in Stranahan Memorial Hall, Castlewellan.

On 14th inst. Mr. T. C. Fulton, A.I.E.E., lectured in the Glasgow City Hall Saloon before the members of the Glasgow and West of Scotland Engine-Keepers' Association, his subject being "The Trolley-Wire System."

NEW COMPANIES REGISTERED.

Makin, Smith & Co., Limited (50,462).—Registered December 9th; capital £1,000, in £1 shares, to carry on the business of an electric light company, electricians, mechanical engineers, suppliers of electricity, electrical apparatus manufacturers. The subscribers (with one share each) are:—J. Makin, 5, Blacker Road, Norty Birkby, Huddersfield; H. Smith, Mount View, Golcar, Huddersfield, book-keeper; J. Bradley, 37, New North Road, Huddersfield, electrician; C. H. Bradley, 37, New North Road, Huddersfield, drysalter; C. A. Bradley, 37, New North Road, Huddersfield, wire merchant; F. R. Bradley, 37, New North Road, Huddersfield, cycle maker; A. J. Taylor, 40, St. John's Road, Huddersfield, clothier. Registered, without articles of association, by A. H. Atkins, Limited, 23, Bouverie Street, E.C.

Great Yarmouth and District Tramways Company, Limited (50,438).—Registered December 8th; capital £1,000, in £10 shares, to construct, purchase, lease or otherwise, acquire any tramways or light railways in Great Yarmouth or elsewhere in Norfolk or Suffolk, to equip, maintain, and work the same by electricity or any other power, and to supply electric light, heat and power. The subscribers (with one share each) are:—E. Lazarus, 83, Cannon Street, E.C., chairman of company; T. R. Thompson, 83, Cannon Street, E.C., director of company: W. Martindale, 83. Cannon Street, E.C., director; W. F. Parshall, 83, Cannon Street, E C., engineer; J. Devonshire, 83, Cannon Street, E.C., secretary; A. Boyter, 83, Cannon Street, E.C., manager; F. R. Davenport, 83, Cannon Street, E.C., engineer. The number of directors not to be less than three, nor more than five; the subscribers are to appoint the first. Qualification £200; remuneration as the company may decide. Registered by Ashurst & Co, 17, Throgmorton Avenue, E.C.

Joslins, Limited (50,492).—Registered December 11th, with a capital of £50,000 in £1 shares, to acquire and carry on the business of agricultural, horticultural, electric, sanitary, and cycle engineers, manufacturing and furnishing ironmongers, &c., carried on by H. and G. Joslin at 107, 108, 109, and 140, High Street, and 1, 2, and 3, Maidenburgh Street, Museum Street, and elsewhere, and to adopt an agreement with J. H. G. Joslin. The subscribers (with one share each) are:—E. J. Moy, 36, Head Street, Colchester, merchant; H. G. Elives, 86, East Hill, Colchester, solicitor; E. T. Bradley, 5, Roman Road, Colchester, salesman; W. Chignell, 9, Queen Street, Colchester, clerk; T. A. Evans, 7, Alexandra Road, Colchester, assistant; A. P. Saunders, 48, Castle Street, Colchester, clerk; H. C. Neville, 31, South Street, Colchester, clerk. The number of directors is not to be less than two nor more than seven; qualification, £100; remuneration, £100 each per annum. Registered by E. G. Elives, 8 and 9, Essex Street, Strand.

Electrical Traffic Syndicate, Limited (50,495).—Registered December 11th with a capital of £1,000, in £1 shares, to interest itself in any and every way in developing and furthering the use of electricity in connection with traction generally. The subscribers (with one share each) are: Arthur R. O'Mahony, 34, Priory Road, Bedford Park, W., secretary; A. F. Dickin, 4, Orlando Road, Clapham, clerk; H. Hartley, 36, Ceders Road, Clapham, clerk; G. A. Monham, 10, Grove Park Road, South Tottenham, agent; W. H. Baker, 50, Beecholme Road, Clapton, gentleman; H. H. Mulliner, Amberley House, Norfolk Street, Strand, gentleman; Maurice Jenks, 66, Old Jewry, E.C., chartered accountant. Registered without articles of association by H. H. Mulliner, Amberley House, E.C.

South Wales Motor Car and Cycle Company, Limited (50,503).—Registered December 11th, capital £5,000 in £5 shares, to carry on the business of cycle, motor, autocar, and vehicle manufacturer, electricians, mechanical engineers, machinists, fitters, founders, millwrights, smiths, wire drawers, tube makers, &c. The subscribers (with one share each) are:—B. L. Downing, Consulate Chambers, Cardiff, shipbroker; H. J. Thomas, 20, Anarthaw Terrace, Barry, accountant; H. Murrell, 34, Mount Stuart Square, Cardiff, surveyor; T. P. Thomas, Bute Docks, Cardiff, exporter; W. E. D. Duncan, 39, Mount Stuart Square, Cardiff, electrical engineer; J. Guthrie, Acacia House, Penarth, shipowner; R. T. Duncan, Wenvoe, near Penarth, solicitor; A. C. Mackintosh, 8, St. John Street, Penarth, solicitor. The number of directors not to be less than two nor more than seven. The subscribers are to appoint the first; qualification 50 shares; remuneration as the company may decide. Registered by Waterlow Bros. & Layton, Birchin Lane, E.C.

Improved Lighting Syndicate, Limited (50,507).—Registered December 12th with a capital of £5,000 in £1 shares, to manufacture dynamos, meters, burners, lamps, engines, accumulators, conductors, machinery, fittings, plant, &c., and to carry on the business of a gas works and an electric light company. The subscribers (with one share each) are:—W. R. Long, 67, Mildmay Grove, N., clerk; E. G. Blake, 100, Inville Road, Walworth, clerk; E. Earl, 42, Digby Street, Bethnal Green Road, N.E., clerk; T. Cox, 18, Chapel Street, Lamb's Conduit Street, W., clerk; A. Turner, 50, Siddons Road, Forest Hill, S.E., clerk; H. V. Potts, 93, Effingham Road, Harringay, clerk; C. S. Oxenburgh, 81, Ramsden Road, Balham, clerk. The number of directors is not to be less than 3 nor more than 5; the subscribers are to appoint the first; qualification, 50 fully-paid shares. Registered by Ashwell and Co., 30, Ely Place, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Malaga Electricity Company, Limited (48,076).—This company's annual return was filed on September 11th, when 8,780 ordinary and 7,000 deferred shares were taken up out of a capital of £57,000 divided into 10,000 ordinary shares of £5 each, and 7,000 deferred shares of £1 each. The latter have been considered as paid, and 15s. per share has been called on the ordinary, and £6,585 paid.

Direct Electric Generator (Foreign Rights) Syndicate, Limited (47,931).—This company's statutory return was filed on October 5th, when seven shares were taken up out of a capital of £100,000, in £1 shares, and no calls made.

D. P. Battery Company, Limited (44,084).—This company has just filed its return, when the whole capital of £10,000 in £1 shares was taken up; 14s. per share has been called on 9,932, and the full amount on the rest, and £7,002 8s. has been paid.

Mather & Platt, Limited (36,368).—This company's annual return was filed on November 17th, when 15,000 shares were taken up out of a capital of £200,000, in £10 shares, and £9 per share called and paid.

D. Hulett & Co., Limited (29,463).—This company's annual return has just been filed. The capital is £35 000 in £5 shares (of which 100 are founders'); 5,900 ordinary and 10 founders' have been taken up, and 4,100 are considered as paid. The full amount has been called, and £9,500 paid on the others.

New Phonopore Telephone Company, Limited (44,651).—This company's registered office has recently been removed from Faraday House, Charing Cross Road, London, W.C., to 85, Queen Victoria Street, London, E.C.

CITY NOTES.

Elmore's Patent Copper Depositing Company, Limited.

Last Saturday a goodly number of shareholders in this company met at Cannon Street Hotel, London, to receive and pass the report and accounts. Notwithstanding the inconvenient day on which it was held, shareholders were present from all parts, and a number of shareholders who had already met together in the Northern and North-Eastern Counties sent a representative specially to London to approve the action of the directors regarding the accounts, and to tender their thanks. It has been the custom to expect anything but harmonious proceedings at either this or any of the other Elmore Companies' meetings, and judging by the stand taken by the auditors in differing from the directors' method of keeping the accounts, a stormy gathering might reasonably have been expected. To the contrary, however, it was clear from the very commencement of Mr. A. S. Elmore's remarks that he had the meeting with him, and there was hardly a discordant note in the lengthy discussion which followed. From first to last there seemed to be a feeling that the company had really turned its worst corner. The directors had themselves advanced money to help the company when shareholders declined to put their hand in their pockets, and it was stated that by means of a certain new invention, and a scheme for the amalgamation of this company with the Wire Company, also a proposal to dispose in some profitable manner of that enormous quantity of land which the company was stupidly saddled with at the commencement of its unfortunate career—the future success of the company might be assured. Whether anything good is to come of these new proposals we should not like to conjecture, the future must decide. An important question was raised by a Shareholder as to the expiration of the patents, the chief of which he thought expired in 1898. The Chairman, however, said in reply, that the improvements which had been invented subsequent to the original patents were of far greater importance to the company, as if anyone were—after the patent had expired—to take the original specification and try to work from it, they would meet with just the same difficulties. Then, further, he thought the circumstances of the case were such that, to obtain an extension of the patent would be a very easy matter. There was also in the discussion a good deal said about the Dumoulin process, and the remarks made were anything but complimentary either to that process or those who are working it out.

From the following report of the remarks made at the meeting, details of the latest scheme will be obtained:—

Mr. A. S. Elmore, F.C.S., chairman, explained that Mr. North, a director, did not seek re-election to the board, in consequence of pressure of work, but he retained his interest in the company intact. Mr. Lewis John Firth, managing director of Thomas Firth & Sons, Limited, of Sheffield, has provisionally accepted the offer of a seat at the board. He and his friends had a very large interest in the Elmore companies. The chairman continued: We are glad to meet you in London, where we have often met before, although not under such favourable circumstances. We have been glad to receive the congratulations of many of our shareholders on the great and continuous improvement effected over former years. The business has been steadily progressing, notwithstanding the keenest competition, and notwithstanding our greatest difficulty of all, that is, the utter want of anything like the amount of working capital which such a business requires, and which is at the disposal of our competitors. An arrangement has certainly now been made by which we shall obtain our raw copper on extremely favourable terms, and there is ground for believing that presently we shall be able to satisfy every requirement that can be expected of the company from the shareholders' point of view. With regard to the accounts, I don't think you can complain of any want of detail in their certification and scrutiny. We have nothing to withdraw from our comments on the

auditors' report, and very little to add beyond saying that the whole gravamen of their contention is this—that the company has created a profit out of the reduction of capital to the extent of £2,500. This is totally inaccurate, and the auditors must be aware that nearly three-fifths of the £2,500 in question are forfeited by us, so to speak, by the fact that this year we have written down the value of the manufactured stock by about £20 a ton. We have certainly made the accounts as good as we could, but absolutely within the limits of what is strictly straightforward and accurate. We set ourselves throughout the year to try by hard work and economy to produce the best possible results with the small means to which you restrict us, and thereby to compel your confidence and support, and we are very pleased with the result, considering the unsatisfactory nature of the trading for the first six months, and you can understand the irritation we felt when we saw an attempt, as we consider it, to rob us of the fruit of our labours by imposing on us an incorrect and mere doctrinaire interpretation of the facts. To compare the result with the previous year's you must add £1,250 of royalties to the profit now shown, which would give us £5,425 profit before charging interest on capital, or £2,721 final net profit after charging interest. It is a great pity to see nearly £3,000 a year being paid away for interest which might be going to the shareholders as dividends, or to develop the business, if we were not saddled with the heavy land mortgage, and if, instead of compelling us to borrow money at a high rate of interest, the shareholders had themselves furnished the needed capital when asked. The item of sundry creditors £2,777 includes £1,750 which is purely nominal, so that trade liabilities hardly exceed £1,000. As to the directors' fees, two of the directors have never drawn anything at all, and the third has only drawn the amount of his out-of-pocket expenses. Debentures were offered to the shareholders in November, 1895; but they were not sufficiently subscribed, and the applications received were returned. However, being perfectly assured of the company's ultimate success, the directors individually advanced £8,000, and although it may seem egotistical, the shareholders owe the present improvement almost entirely to that financial help, given at a time when the shareholders neglected or declined to come forward. However, perhaps your unkindness was a blessing in disguise, as it has saved the company from a heavy debenture charge extended over many years, whereas you can pay us off at very short notice. Never had the company so many orders and contracts in hand, or at such good prices as now, and contracts, renewed with us from time to time, are proof of the satisfaction we are able to give them. We have for a long time been seeking to be appointed Admiralty contractors. We believe our hopes will not much longer be deferred, seeing that Elmore material is now in very general use, and that, too, for some years, both in this country and in the French and German Navies, &c. As regards our 114 acres of freehold land, which is about 107 acres more than we use—this unfortunate burden, taken up by the company in its early days, very largely contributed to our subsequent embarrassments, by reason of the lock-up of our own capital therein, necessitating costly loans for carrying on our proper business, and of the heavy annual mortgage interest, so that directly and indirectly we reckon that the land last year cost us an expenditure of £2,654 in interest which might otherwise be going to the shareholders, and of this sum £1,200 was entirely unremunerative. Our intention, therefore, is to realise the land as quickly as possible—at least to the extent of paying off the mortgage, and so escaping the charge for interest thereon. The estate is certainly improving in value intrinsically, and we are daily expecting the umpire's award as to the price to be given us for the three-quarters of an acre taken by the Great Northern Railway. Now as to the more important items of information. First as to our raw copper supplies. In a few words, we have, in conjunction with the Wire Company, entered into a contract whereby for some years to come, in consideration of our jointly finding the working capital (which is almost completed), and of which we, ourselves, practically have the spending control, and which is perfectly secured to us by five per cent. mortgage debentures on the property, we have the entire output of an excellent copper mine at a price which, including shipment to the nearest landing point and delivery to our own works, gives this company a large rebate in cash on the market price of copper from day to day, and is equivalent to several thousand pounds a year to the companies. If we had achieved nothing more than this, I think we should have been entitled to your congratulations. It costs you nothing whatever except the interest we pay on the money found, and towards that we get 5 per cent. from the mine, as already stated. This is not merely a hope for the future, but something actually being enjoyed, and I have understated the facts rather than otherwise. We shall not obtain the full benefit of this arrangement for about two or three months yet. Then there is a matter of far greater importance still to you. No one capable of judging can justly deny that the Elmore process uniformly produces a much better finished article than can be uniformly produced by any other known process of copper manufacture. One by one the various hostile misconceptions in regard to our process have been destroyed by stubborn facts, except that one still hears sometimes that it is slow in its operation compared with its rivals. This, however, we entirely deny, although there has been some excuse for this mistake, inasmuch as our deliveries have been slow. But this has been due to shortness of capital for buying raw material, and not to the slowness of the process; for, under equal conditions, we will guarantee to produce a superior finished article in less time than our competitors. However, this last remaining reflection will very soon lose even its present excuse, for we have, in conjunction with the Wire Company, acquired and worked out at the Leeds works a method which is carefully patented, whereby the rate of manufacture is increased enormously. That there can be no doubt as to the success of this method, or as to the value of it to us, the results already obtained fully prove. [This invention was later on stated to be patented by a brother of the chairman, a Mr. Elmore, now in India.] The magnitude of its importance to us, and of its bearings on the entire electrolytic copper trade, I will not now dwell upon here; but you will not fail to appreciate this fact, which is well within the truth, namely, that where an order has previously taken a fortnight to execute it will be ready in under 48 hours at a fraction of the cost, and I am far from wishing to be understood that even this marvellous expedition is the limit attainable. If I mistake not, it means at least a great extension of your business, a very rapid turnover of your capital, large profits, and possibly a revenue of royalties. In view of these improvements and advantages, in which both this company and the Wire Company are jointly interested, it has been thought very desirable to amalgamate the two concerns in one new company, in which the rights of the old shareholders will be scrupulously maintained, and which shall be amply furnished with all necessary capital, which, by the by, will be much less, relatively, under the new conditions than under the old. We cannot lay the scheme before you to-day in detail; but it has our most careful consideration, in which we are being ably advised and supported by gentlemen outside the members of the board, and it will be submitted to the shareholders at the earliest possible date. We shall spare no effort to bring about an early consummation of the good things which I have had the pleasure to announce to you to-day. I now beg to move: "That the directors' report and statement of accounts submitted to this meeting be received and adopted."

Mr. Ewan seconded the motion, and complimented the directors on the greatly improved position to which they had brought the company. He expressed the opinion that the board had given perfectly satisfactory explanations in regard to the points of dispute with the auditors.

Mr. Lamont supported the motion, and remarked that they now appeared to be seeing something like daylight in the matter of the Elmore Company.

After remarks from several shareholders the motion was carried unanimously.

Mr. L. J. Firth was elected a director.

Instead of the old auditor, the original auditor, Mr. Close, of Leeds, was elected at a fee of 25 guineas. Very hearty votes of thanks to the chairman and secretary (Mr. Shurmer) were carried with unanimity, and the proceedings closed.

Crompton and Co., Limited.

Mr. J. Trotter presided over an extraordinary general meeting of the above company, held on Monday at the Cannon Street Hotel, for the purpose of considering the advisability of giving the Board power to borrow more money.

The Chairman said that when he last met the shareholders in the summer he told them that they were extremely active at the works. They had no idea at that time that there would be such a remarkable increase in the business that had taken place in the last six months as had actually taken place. He told them that at the close of the last period of accounts they were paying something under £500 a week in wages at Chelmsford, and at present they were paying something over £750 a week—an increase of 50 per cent. in labour; so that they would readily understand that there must be a great deal more to be done there. The conditions under which they were working were about as unfavourable as they could be at the present moment, because they were not yet into the new works. They had to contend against the difficulties of having to employ the men day and night shifts, instead of having them at work only in the day time. They also had great difficulties in moving their materials about, owing to the destruction caused by the fire. They also had to have extra power to conduct the electric lighting at Chelmsford, and altogether they were working under very unfavourable circumstances. But notwithstanding that, he was pleased to be able to tell them that the private accounts which they had taken out half-yearly, as well as the public accounts published yearly, had shown for the six months a very considerable profit, which the directors thought was unusually satisfactory, considering the conditions under which they had to work at the present time. Not only was there a great increase of activity at the present time at the works, but continued activity was practically assured for a considerable period in the future, in consequence of the satisfactory contracts which they were about to enter into. Under those circumstances they were obliged to provide extra funds for the work, and that was the reason they came before them and asked for an increase of their borrowing powers from £100,000 to £150,000. When he told them that the stock during the past six months had increased by the sum of £9,500, and that that was not stock lying by, but was work in progress through the shops; and when he told them that their book debts of current customers had increased from the sum at which they stood in the last account by the sum of £15,000, they would see that altogether those two items represented no less a sum than £24,500. In the same time their trade creditors only increased by £400, so practically they had a demand for £24,000 more than they required at the time the last accounts were published. Under those circumstances, they felt it prudent and right to come and ask the shareholders to allow them to increase the borrowing by a sum which would be considerably within £50,000. But they thought it right to take increased powers with a view to large contracts they saw before them. He could not, of course, tell them whether the activity in the electrical world would continue or not. At present, there was a large amount of business coming to them. If that increased activity did not continue, they would not require that extra sum of money for a very long period. He could not, however, foreshadow what would happen. Business might go on increasing and increasing, and he hoped it would, for it meant dividends again to the shareholders. He thought the next six months would show even better results, but they could not expect to be really

prosperous before they got into their new works, because of the expensive manner in which they had to handle their goods at the present time. The works were making satisfactory progress, and they hoped to be in them some time next spring, and there was no doubt that they would be able to handle the heavy machinery and work in a much more economical way than at present, and if business continued good, they could look forward to considerable prosperity again. The policy of the board had been one of centralisation at Chelmsford. They had quite recently got rid of the Lilley Road premises, which had been a drag on them, and they would next year clear out of them, and take such portion of the material as they chose to Chelmsford. He would move: "That the directors be, and they are hereby authorised, to borrow any sum or sums of money on such security, and upon such terms as to interest or otherwise as they may deem fit, provided that the amount borrowed shall not exceed in the whole, without the further sanction of a general meeting of the company, the sum of £150,000."

Mr. Crompton, in seconding the resolution, alluded to the progress of the new works, and said they had orders in hand to keep them going at better prices than during the lean years through which they had been passing. He thought a dividend paying period was approaching, and as one who had suffered from a lack of dividends, he was doing all he could to bring it about.

Replying to Mr. Thornton and Mr. Evans, the Chairman said they had facilities for borrowing the money required at a reasonable rate of interest. He still thought there should be a writing down of assets in the balance-sheet, and should bring a scheme forward for dealing with the shares of the company on an equitable basis; but before dividends were paid, they must get the balance-sheet in a healthier condition. He did not think a dividend would be long deferred if they continued as they were now.

The resolution was then agreed to.

British Electric Traction Company, Limited.

The statutory general meeting of the above company, followed by an extraordinary meeting, was held at Winchester House on Monday afternoon, under the chairmanship of Sir C. Rivers Wilson.

The Chairman, after stating that the meeting was a formal statutory one to comply with the Companies' Acts, said there was afterwards to be an extraordinary meeting to pass certain resolutions which he would explain. The company was registered on October 26th, and they proceeded to allotment on £200,000, the proportion of capital required to enable them to apply for an official quotation, which they were in the process of obtaining. The shares were taken up by the shareholders of the Pioneer Company, whose business they took over, and by the Electric and General Investment Company and their friends who had confidence in the future of electric traction. They had proceeded to work upon the lines set forth in the prospectus. One scheme, which was very far advanced, was that of taking over the North Staffordshire Tramways and fitting them with electrical appliances, or, rather, to carry out an arrangement with the Brush Company, who are under contract with them for obtaining electrical apparatus for the North Staffordshire Tramways. In a short time, he hoped they would hear that active steps had been taken for the equipment of those lines. He would like to rectify a little misapprehension existing in the minds of certain persons who had not followed the genesis of the company. These persons seemed to think there was some connection between the British Electric Traction Company and the objects of the new motor car company, but he wished it to go forth that there was no connection of any sort between the two companies. The most important of the new schemes which they had promoted was, no doubt, that of the amalgamation of several important undertakings in Staffordshire. It was proposed to deal with four companies, and to go to Parliament for powers to enable them to amalgamate and extend, and so forth. The first was the South Staffordshire Tramways; then the steam line of the Dudley and Wolverhampton Company, and the Dudley and Stourbridge Company, and the Wolverhampton Tramways Company. They were promoting a Bill in the ensuing session, under the title of the Birmingham and Wolverhampton and District Tramways Bill, with the object of amalgamating the existing tramways, and equipping the same with electrical traction. The Bill provided also for making physical junctions between existing tramways and a uniform gauge throughout, and powers were also taken for much needed extensions. The Wolverhampton Tramways Company was worked by horses; the Dudley and Wolverhampton, and Dudley and Stourbridge, was worked by steam, as was also the Staffordshire Company. Negotiations had been pending with those companies for the purchase of their undertakings. In one case, at least, a definite contract had been concluded, and negotiations in the other cases were advancing. The board proposed a very comprehensive scheme, which embraced a large tract of country. Of course, it was possible they might not arrive at satisfactory terms with one or other of the companies, and if so, they would proceed with the rest. Still, he hoped to be able to induce all to come into the scheme. In that important scheme they must be in agreement with the local authorities, and obtain the approval of the Board of Trade and Parliament; and the shareholders must not be surprised if all the difficulties were not removed in one session of Parliament. The chairman then explained the necessity of the extraordinary meeting which would follow, and said they had found there were conveniences and advantages in certain cases in applying the principles and provisions of the Light Railways' Act, passed last August, to their undertakings. All the schemes he had spoken about had been brought forward under the provisions of the Tramways Act; but as regarded facility of procedure in the preliminary stages, it had been found that the application of the Light Tramways Act afforded great advantages, and so they proposed to apply that Act to obtain light railway orders for tramways at Crewe and in the Potteries—an extension of the other lines over which they had control—and at Norwich and at Hartlepool. As regarded Hartlepool, it was proposed to apply for the order in the name of a local company; and as to the other three, they proposed to go to the Light Railway Commissioners and state their case, and obtain their recommendation to the Board of Trade, who, he hoped, would issue an order. With respect to the three Bills under consideration that day he would merely state that at Crewe there were no tramways of any sort at present, and the Town Council had passed a resolution in favour of electrical tramways. The order for the Potteries was under an arrangement with the local authorities, by which they bound themselves to make further extension of the tramways in the district. As they were aware, they had a contract with the North Staffordshire Company for electrical equipment of eight miles of tramway. During the last session of Parliament a provisional order was obtained for an extension of those tramways for a total line of about 12 miles, and the present order was for a further extension in various directions, so as to connect the towns of Longton, Stoke, Hanley, Burslem, Tunstall, and Newcastle-under-Tyne by one system of electrical traction. At Norwich they were promoting a light railways order for tramways within the city, with extensions to Thorpe, Eaton, Costessy, and other places.

In compliance with the rules of the Board of Trade under the Light Railways Act, 1896, and the provisions of the Companies Act, 1862, an extraordinary meeting was then held for the purpose of considering applications proposed to be made during the present month to the commissioners appointed under the Light Railways Act, 1896, for the following orders, drafts of which were submitted to the meeting, viz.:—(1) The Crewe light railway order; (2) the Norwich and District light railway order; (3) the Potteries light railways order. Resolutions were passed approving of the said orders respectively, subject to all such additions, alterations, and variations, as the Light Railway Commissioners or the Board of Trade may think fit to make therein.

Venezuela Telephone Electrical Appliances Company, Limited.

At the annual general meeting of this company, held on Thursday, last week, at 28, Victoria Street, S.W., under the presidency of Sir Douglas Fox, the Chairman stated that the shareholders had every reason to be satisfied with the way in which the business had been conducted in Venezuela, and with its gradual and steady growth. The net revenue of the company during the past year amounted to £9,333 11s. 6d., which enabled the board, after payment of debenture interest, to recommend the declaration of a dividend of 4 per cent. for the year on the capital of the company, and to place £2,500 to the reserve fund. The number of subscribers had increased from 2,287 on June 30th, 1895, to 2,524 on June 30th, 1896, since which date there had been a further increase of about 100 subscribers.

Eastern Telegraph Company.—Payment will be made on January 15th of interest of 3s. per share, less income-tax, being at the rate of 6 per cent. per annum on the preference shares for the quarter ending December 31st, and of the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income-tax, in respect of profits for the quarter ended September 30th. The transfer books will be closed from January 8th to 15th, both days inclusive.

The Electric and General Investment Company, Limited.—The board has declared an interim dividend on the capital paid up on the ordinary shares of the company at the rate of 10 per cent. per annum for the six months ended November 30th, 1896, the dividend to be payable on and after January 1st to those shareholders registered in the books of the company on November 30th, 1896.

City of London Electric Lighting Company, Limited.—The secretary gives notice in our "Official Notices" that the transfer books and register of holders of £400,000 5 per cent. redeemable debenture stock will be closed from 17th to 31st inst., for the purpose of preparing interest warrants.

Stock Exchange Notice.—Application has been made to the Stock Exchange Committee to appoint a special settling-day in, and to grant a quotation to—British Electric Traction Company, Limited—30,000 ordinary shares.

Brush Electrical Engineering Company, Limited.—The transfer books of the 4½ per cent. second debenture stock will, in view of interest payable on January 1st, be closed from to-day to that date, both days inclusive.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending December 13th, 1896, were £1,075; week ending December 15th, 1895, £1,014; increase, £61; total receipts for half-year, 1896, £23,022; corresponding period, 1895, £21,541; increase, £1,481.

The Liverpool Overhead Railway Company. The receipts for the week ending December 13th, 1896, amounted to £1,098; corresponding week last year, £1,081; increase, £17.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 11th, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,583.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, Dec. 9th.	Closing Quotation, Dec. 16th.	Business done during week ended Dec. 16th, 1896. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	4 %	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	8½— 9½	8½— 9½	...	
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	£2 9s.	51 — 54	51 — 54	52½	51½
2,993,560£	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	£4 18s.	95½ - 96½	95½ — 96½	96⅝	95
2,993,560£	Do. do. Defd.	Stock	...	...	...	9⅜ - 10½	9⅜ - 10½xd	10½	9⅜
130,000	Brazilian Submarine Teleg., Ltd.	15	6¼% §	7 %	7 %	14⅜ - 15½	14⅜ - 15½xd	15⅝	15
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	5 %	113 - 117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	§	2½%	4 %	3¼ - 3⅜	3¼ - 3⅜	...	...
16,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	165 —170	165 —170	163	...
224,850	Consolidated Telep. Const. and Main., Ltd. .. .	10/-	2 % §	1½%	1½%	1/16— 1/16	1/16— 1/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	11½ — 12½	11½ — 12½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18½ — 19½	18½ — 19½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½ - 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	10⅜	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	4½%	4½%	107 —110%	107 —110 %	...	...
60,710	Direct United States Cable, Ltd.	20	2⅜% §	2 %	2¼%	9¼— 9⅜	9¼ - 9⅜	9⅜	9 9/16
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6¼% §	6¼%	6¼%	17 — 17½	17 — 17½	17⅜	17⅛
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 %	6	17½ - 18½	18 — 19	18½	18 7/16
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	127 —130	127 —130	128½	127½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17 — 17½	17 — 17½	17 7/16	17¼
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	1 1 —105	101 105	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	102 —105	102 —105	...	..
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	128 —131	128 —131	129	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	01 —105	101 —105	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	102 —105	102 —105	...	..
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	106 —109	106 —109	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	108 —111 %	108 —111 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅜% §	4⅜%	4⅜%	10⅜ - 11¼	10⅜ - 11¼	11	10⅜
180,042	Do. do. 6 % Pref.	10	6 % §	6 %	6 %	17 — 17½	17 — 17½	17⅛	17¼
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	8⅜%	10 %	24 — 25	24 — 25	25	24½
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	53 — 56	53 — 55	55⅜	54½
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	109 —112	109 —112	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	4 %	2 — 2¼	2 — 2¼	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 %	5¼%	7 — 7¼	7 — 7¼	7¼	7
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	17⅛	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅜— 6⅞	6⅜— 6⅞	...	...
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —108	105 —108	107¼	107
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4½%	5 %	1⅛ - 1⅜	1⅛ - 1⅜	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	108 — 111	108 —111	...	...
11,839	Reuter's Ltd.	8	0 %	*nil*	5 %	7 — 8	7 — 8	7	...
3,381	Submarine Cables Trust	Cert.	...	...	...	138 —143	138 —143	139½	139
58,000	United River Plate Teleph., Ltd.	5	...	3 %	4 %	3¼— 3⅜	3¼ - 3⅜	...	...
146,783£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	103 —108	103 —108	...	...
15,509	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	*nil*	4 %	5 — 6	5 — 6	...	..
238,360£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 —106	103 —106	...	...
30,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	*nil*	½ - 1½	½ - 1½	...	
156,865£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	8 %	96 —101	95 —101	...	...
54,248	Western and Brazilian Teleg., Ltd.	15	2½%	3 %	3 %	7½— 8	7½— 8¼	...	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6¼— 6⅝	6¼— 6⅝xd	...	...
33,129	Do. do. do. Def. Ord.... ...	7½	...	1 %	1 %	1½ - 2	1⅝ - 2¼	...	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	104 —108	104 —108	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	104 —108	104 —108	...	..
88,321	West India and Panama Teleg., Ltd.	10	⅞%	⅞%	⅞%	1½— 1⅝	1½— 1⅝	1⅝	1½
24,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11½ - 12	11½ - 12	12	11¾
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9½— 10½	9½— 10½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	108 —111	109 —112	111	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	107 —112	107 —112	...	...
164,300£	Do. do. 6 % Star. Bonds ...	100	6 %	6 %	6 %	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	5 %	9½ — 10	9½ - 9⅝	9½	9⅜
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	8 — 8½	8¼— 8⅜	8⅜	8¼
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	4½%	114 —117	114 —117	...	
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	5 %	15½ — 16½	15½ — 16½	16½	16
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16 — 17	16½ - 17½	17	16⅝
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	128 —133	128 —133	...	...
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	..	*nil*	8 — 9	8 — 9	...	..
20,000	Do. do. do. 6% Pref., 40,001—50,000 ...	10	...	...	6 %	13⅜— 14½	13⅜— 14½	14½	13⅞
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	...	7½— 8½	7½ - 8½	7 13/16	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000	10	2½%	3 %	4 %	13 — 14	13 — 14	13⅜	13½
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem., £1 paid	10	...	...	...	6½— 7	6½ - 7	6 13/16	...
150,000£	Do 4½% first mortgage debenture stock	...	4½%	4½%	4½%	121 —124	21 —124	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	2 %	10 — 11	10 — 11	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	12 — 13	12 — 13	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9½ - 10½	9½ - 10½	10¼	9⅝
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	106 —109	106 —109	..	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000	*	4 %	5 %	7 %	11 — 12	11 - 12	11⅝	11

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share †	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation Dec. 9th.	Closing Quotation, Dec. 16th.	Business done during week ended Dec. 16th, 1896. Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	5 % §	2½%	...	⅞— 1⅛	⅞— 1⅛	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	3 %	...	1 — 1¼	1 — 1¼	...	...
125,000	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	110 —113	110 —113	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	96 —100	96 — 100	...	...
9,104	Central London Railway, Ord. Shares	10	...	...	...	9⅜— 10¼	9⅜— 10¼	10¼	10⅛
207,649	Do. do. do. £4 paid	10	...	...	...	3⅞— 4⅛	3⅞— 4⅛	...	...
630,000	City and South London Railway	Stock	1 1/16%	1⅛%	1 3/16%	53 — 55	53 — 55	54	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	3 % §	*nil*	*nil*	1⅜— 2¼	1⅜— 2¼	1⅞	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	7 %	5 %	5 %	1⅝— 2¼	1⅝— 2¼	2	1⅝
17,139	Do. do. do. "A" Shares 01—017,139	5	7 %	5 %	5 %	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	4½%	103 —106	103 —106	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	5 %	1⅜— 1⅝	1⅜— 1⅝	1⅜	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2½— 3	2½— 3	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	3/16— 5/16	3/16— 5/16	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	¼— ½	¼— ½	...	...
9,600	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	*nil*	10½%	10⅛— 11⅛	10½— 11½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	8 %	17½ — 18½	17½ — 18½	...	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	4½%	109 —114	109 —114	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	10 %	20½ — 21½	20½ — 21½	21	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	105 —108	105 —108	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1 %	1½%	2⅝%	14¼ — 14¾	14 3/16 — 14 7/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	17 — 17½	17 — 17½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	15 %	39 — 42	39 — 42	40¾	39½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £6 paid ...	10	...	...	...	7⅜ — 8¼	7¾ — 8¼	7⅞	...

Quotations on Liverpool Stock Exchange. † Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9¼.
Electric Construction Corporation, 6 % Debentures, 104—106.
House-to-House Company (£5 paid), 4½—5.
Do. do. 7 % Preference, of £5, 8½—9.
Do. do. 4½% Debentures of £100 109—111.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 10—10½; 1st Preference Cumulative 6 %, £5 (fully paid), 8¼—8¾.
London Electric Supply Corporation, £5 Ordinary, 1—1¼.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 7½—8.

* From Birmingham Share List.

Bank rate of discount, 4 per cent (October 22nd 1896).

STANDARD CELLS.*

By HENRY S. CARHART.

STANDARDS of E.M.F. have lost none of their interest to electricians. In fact, since the legalisation of the Clark cell, they are of more importance than before. Two interesting papers on standard cells have recently appeared, one by Prof. Ayrton and Mr. Cooper on the "Variations in the E.M.F. of Clark Cells with Temperature,"† and the other by Mr. W. Hibbert, in the London *Electrician*, July 3, on "A One-Volt Standard Cell."

The former paper is an elaborate account of an investigation of the lag of E.M.F. behind the temperature changes of the Clark cell. This lag is appreciable for comparatively slow changes of temperature. The effect is an apparent diminution of the temperature coefficient. If a cell is placed in a water bath which differs by as much as 3° C. from the previous temperature of the cell, the lag after half an hour may amount to as much as 0·1 per cent. Generally it will be less than this. This is equivalent to an error of 1° in reading the temperature.

The authors of the paper say that "it has for some time past been suspected that the lag of the E.M.F. of a Clark cell behind the temperature was due, not merely to the mean temperature of the cell itself lagging behind that of the bath, but to time being necessary for the variations of the amount of crystals in solution and for diffusion to take place." To say that this effect has been "suspected" is ignoring much that has been written on the subject. This phenomenon I described in my "Primary Batteries" in 1891, and explained that the temperature coefficient of a normal Clark cell is made up of two parts, one of which is "a secondary change resulting from a variability in the density of the zinc sulphate solution." The effect on the responsiveness of the cell to temperature changes is also described. This slowness of the Clark cell in attaining an equilibrium of E.M.F. after a change of temperature was described also in my paper on "A One-Volt Cell," in the *American Journal of Science*, July, 1893. Attention was called to the same phenomenon in Section A of the B.A. meeting at Edinburgh in 1892 by Mr. Glazebrook and myself. No one who has made some thousands of comparisons of Clark and other standard cells could fail to note the lag described. But it is almost wholly eliminated in cells containing no crystals to dissolve on heating.

Mr. Hibbert makes no mention in his paper of any previous work on a 1-volt cell; and Mr. Fisher, who investigated Hibbert's cells, says* if these cells are successful in passing "time tests they will certainly supply a want as the missing full volt standard." This full volt standard has not been missing since the publication of my paper on the subject in 1893. They have been used as practical standards by the Weston Electrical Instrument Company, which supplies the standard voltmeters for the entire country. Under date of September 19th, 1895, Mr. R. O. Heinrich wrote me that one of these cells, which had unfortunately leaked through its seal, "was like the apple of my eye, and many silent hours of the night were spent on its study. . . . . The beauty about the cell was that its E.M.F. was probably 0·02 per cent. of 1 volt at 20° C." Again, he says: "I have quite as much confidence in their constancy as I would have in a Clark cell, not mentioning the comfort of the small temperature coefficient." The "missing link" was therefore supplied before our friend in England took the matter in hand.

The principal object in writing this article is to give some account of a few standard cells which I have kept for several years. My old No. 1 Clark, contained in a 5-inch test tube, was set up in June, 1887. That it has suffered no impair-

* New York *Electrical World*.
† Proceedings Royal Society, Vol. 59. (See also ELECTRICAL REVIEW, November 27th, page 716.)

* *Electrician*, March 13th, 1896.

ment by reason of frequent service and advanced age is evident from the following comparison made October 26th:

No. of cell.	Set up.	Temp., C. Degrees.	Res. to balance.
1	June, 1887,	17·4	9301
31	Sept., 1892,	17·4	9301
35	April, 1895,	17·4	9301·3
30	Sept, 1892,	16·45	9310·4

A reduction of the last to the temperature of the others gives 9303·4. These numbers are the resistances out of 10,000 ohms required to balance in the potentiometer or Rayleigh method of comparison. No. 1 has been tested from year to year by comparison with other standards and by the silver voltmeter method. Its voltage is fully up to the legal standard still. It has been compared with a standard made after the legal specification contained in the law of Congress passed in 1894, and the agreement was found to be almost exact. This legal standard has since cracked at the negative terminal. This difficulty, which was found by Lord Rayleigh, can be gotten over by sealing in the platinum wire with lead glass. In a recent letter from Dr. Kahle, in Berlin, he says that he has about 30 of these cells five years old, and none of them show any break at the negative pole.

Occasionally a Clark cell exhibits a variation from the mean of others; hence we should not put all our eggs in one basket by trusting to a single cell. Good agreement with two or three is a sufficient ground for confidence in the mean.

Turning now to the calomel cell, I have the first four cells which I made for the purpose of determining the density of the solution required to give 1 volt. Numbers 1 and 2 were never very near 1 volt, but numbers 3 and 4 were much nearer. Regarding their constancy, I append relative values compared with normal Clark cells four years ago, and at present:—

No. of cell.	Set up.	Temp., C. degree.	E.M.F., 1892.	E.M.F., 1896.	Temp. C. degrees.
1	Oct., 1892.	15	0·9975	0·9975	14·6
2	Oct., 1892.	15	1·0328	1·0323	14·6
3	Oct., 1892.	20	1·0002	1·0001	20
4	Nov., 1892.	14·7	1·0003	1·0003	14·4

No. 5 was sent to Mr. Heinrich in May, 1894, and it has since remained in his possession. In May, 1893, it had an E.M.F. of 1·001 at 20° C., compared with No. 30 Clark. It had the same value the following November, though in the meantime I had carried it in my pocket to Chicago and back. March 8th, 1895, Mr. Heinrich compared it with the one above referred to, and found its E.M.F. to be 1·0012 volts; from the silver voltameter test he found precisely the same value, both at 20°. March 25th, by comparison, it was again 1·0012, and by the silver voltameter 1·6010, both at 20°. I have the data of a number of comparisons made on this cell, giving an E.M.F. ranging from 1·0005 to 1·0011 at 20° C. To reduce all the comparisons to the same temperature, a coefficient of 1·001 per cent. was used.

The only difficulty of importance encountered in making 1-volt calomel cells is to secure sufficiently pure zinc chloride, free from the oxy-chloride, and to adjust the concentration to give 1 volt. The percentage variation of the E.M.F., with a given variation of the concentration, is greater with zinc chloride than with zinc sulphate. These difficulties are not insuperable, and with the methods now employed I have great faith in the permanency of the calomel cell. Their convenience is beyond question, both because the E.M.F. is 1 volt, and because their temperature coefficient is almost negligible—about one-eighth that of the normal Clark cell.

"A NEW METHOD OF DETECTING WASTE POWER IN ELECTRIC RAILWAYS."

An article in the *Electrical World* for October, under the above heading, written by Mr. Harold P. Brown, will well repay perusal.

The gist of the article is that the writer has found that the efficiency of several modern and well-equipped electric lines examined by him was very far below what might have been expected from the efficiencies of the generating plant, motors, and gearing, and from the copper section; and that this loss of efficiency was demonstrated to be due to excessive resistance at the rail bonds.

To prove this, Mr. Brown made use of a special milli-voltmeter, reading to 0·0001 of a volt, connected to the two rails on each side of the joint, with simultaneous measurement of the current carried. He points out that the current must not be assumed, because, as a matter of fact, he found the rails in some cases carrying an insignificant part of the current supposed to be flowing along them.

The electric joints used were the usual "Chicago bond," and were only 18 months in use. They had been made by a competent workman, and upon examination were found to be mechanically solid; but—and here is the point—"the contact surfaces of the copper and of the steel proved to be entirely covered with a black, greasy deposit."

The writer gives the efficiency of two lines as "less than 45 per cent. at heavy load," and continues:—"Each of these roads has a finely-equipped power plant, multipolar dynamos, modern types of motors, with series parallel control, excellent tracks, and, apparently, ample feeders."

It certainly seems from this as though electric railway engineers, on lines showing low efficiency, might with advantage examine the joints in the manner proposed.

Mr. Brown appears to regard some form of continuous rail as the solution; but this does not appear very feasible, and has, indeed, been tried, with not very satisfactory results.

Any certain remedy will, no doubt, be expensive; but 45 per cent. efficiency is ruinously expensive, and its increase to 65 per cent. or 70 per cent. would warrant any reasonable expenditure in the interests of the line alone, to say nothing of the possible damage by electrolysis to neighbouring pipes, and the mischief done to the prospects of electric traction by the reports of its occurrence.

THE HEILMANN LOCOMOTIVE.

In the new Heilmann locomotives which are shortly to be tested, the general appearance will be, at one end that of an ordinary locomotive boiler carried on a plate frame, and at the other end an equally long closed in vehicle similarly carried. The plate frame platform is continuous, and deeper at the centre. Each end is carried on a bogie of four axles, the wheels as close as possible to each other, and only 1·16 metre diameter, and with a wheel base of 4·1 metres. The centre pins of the two bogies are 11·300 metres apart, the total wheel base is thus 15·400 metres.

The engine will in fact, be a very big affair, fully deserving of the name of a travelling central station, which has been applied to it. The principle of subdivision is carried very far. Each of the eight axles carries a motor, so that we have an express locomotive with 16 driving wheels, and we may compare it with the English Great Northern engine of two driving wheels and six carrier wheels. There is no coupling of the various pairs of wheels, but every motor runs independently. There are to be two six-pole generators of, together, 2,000 amperes capacity at 455 volts, but for a short period their combined output may be 4,000 amperes. An enormous grate surface of 36 square feet (3·34 m^2.) is provided with 177 square feet of fire-box surface and 1,818 feet of tube surface, in 351 tubes of 1·77-inch outside diameter, the tubes being 12·46 feet long.

Separate excitation of the fields of both the generators and motors is given by a 28 H.P. Willans engine driving a four-pole dynamo.

At 62 miles per hour the power of the eight motors is 1,000 H.P. This represents a torque of 748 lbs. at the tyres, but the maximum torque is 2,640 lbs. at the tyre, the diameter of which is 45·67 inches.

The new Heilmann engine will thus have 12 cylinders. Though ordinarily the motors are in multiple, they can be grouped in two series of four each for maximum tractive effort at slow speed. The axles pass through the sleeve which carries the motor armatures, and the driving is by spiders. This, of course, will relieve the rail and wheel of the unsoftened pounding effect of the heavy armatures, but it will introduce another trouble. The vertical play of the springs producing more or less eccentricity of the armatures and axles must compel the armature to vary its speed of

rotation instantaneously, and we think for high speed work trouble may arise to the coils of the armature. This has been foreseen and guarded against, if we may judge from the illustration, by placing springs between the wheels and the spiders in order to ease the shock of sudden change of speed. It is assumed that the indicated H.P. will be 1,350, the steam engine efficiency 90 per cent., that of the generators 95 per cent., and of the motors 90 per cent. Then with a 2 per cent. loss in the conductors, the net efficiency is 75·4 per cent., so that there is 1,000 H.P. at the tyres and 657 H.P. at the draw bar.

Compared with the Empire State Express engines, the I.H.P. at 70·5 miles was 977, but 1,120 had been once shown. The train hauled was 340,000 lbs. That estimated at only 62 miles to be hauled by the Heilmann is 355 tons. The American engine had only 27·3 feet of grate surface, however, and the comparison can hardly be carried through. What would an English locomotive do if only fitted with a grate measuring 9 feet × 4 feet? We think it would beat the Heilmann engine.

We still fail to see that for the purpose of rapid acceleration the complication of the Heilmann engine can be justified, and Mr. Ward Leonard, who describes the engine in the *Electrical World*, seems to see its principle as useful in tunnels, because the combustion of the fuel being more perfect, the sulphurous fumes will be reduced, and so on. This sort of a plea is very poor, and had better have been left out. So long as the furnace discharges at the funnel the sulphur will be all there, no matter what the combustion is like, and the only reduction would be in the matter of dirt and soot. We certainly doubt any improvement being possible over the results of English locomotives when fitted with the brick arch, nor do we think the Heilmann engine will be very clean unless it have a brick arch. It seems ridiculous to talk of the Heilmann engine as suitable for the Baltimore tunnel in place of the present electric locomotives there used. The present motors have no fires, but are purely electric, picking up current in the usual way. Why advocate the Heilmann in such a place, when electricity was adapted simply to abolish furnaces being carried through the tunnel in a state of high combustion? We believe, now, the steam locomotives are hauled through with fires as inactive as possible.

REVIEWS.

The Commercial Organisation of Factories. By J. Slater Lewis.

As one reads this fascinating book, one finds difficulty in deciding whether the balance of our congratulations are due to Mr. Lewis for having produced this admirable work, or to the electrical industry for having produced Mr. Lewis.

The style throughout is easy and lucid, and although the subject belongs to the order called "dry," the reader may set forth on his journey of 500 pages without trepidation, for when seated in Mr. Lewis's canoe, drifting easily with the stream, the skipper explaining the panorama as it passes, he finds that ledgers, omnibus journals, and even "returned empties," have more in them than he had imagined.

The organisation of an engineering factory, particularly when the work is of a diversified character, involves difficult problems, and in many, probably the majority of cases, it is only when chaos has become chronic that any attempt is made to produce order by organisation; the result is usually a piece of patchwork without design, giving minimum result for maximum effort. We cannot imagine the manager of any old established concern reading this book without gleaning many ideas for improving his present methods, and to new companies starting business it will prove a veritable god-send, for with it they can obtain for a few shillings something better than that which usually costs them many thousands of pounds to evolve by the barbarous process of "trial and error."

Mr. Lewis's "factory" is supposed to belong to a limited company, and the book opens with a chapter on directors and their duties. Our opinion is that the author's "directors" should be well paid for their services, considering the amount of work he expects from them. But he expects much more from the "manager"—rather more, we think, than can be got out of ordinary flesh and blood, even without writing a book between times.

The secretary is described in three clauses; he is simply a machine. In our opinion, a secretary should be this, and very much more: indeed, if he be worthy of the name and office, he should be capable, on occasion, of conducting the commercial side of the business, and of relieving the manager of all anxiety as to the daily routine.

The chapter on the drawing office is eminently practical, and full of useful hints. Everything that can be done in the way of furnishing, warming, and ventilating a drawing office will tend to improve results.

The author does not attempt to show how a draughtsman can be made to understand that he is only one of the cog-wheels in a machine for making dividends, and not an ornamental appendage; but he speaks up for "lady draughtsmen," or, as we should prefer to express it, "for the presence of ladies in the drawing-room." We imagine, therefore, that Mr. Lewis fixes his hopes on the succeeding generation; but he says "not a word." He is probably thinking it out, ready for a chapter in the second edition, under the heading of "cumulative heredity."

The question of accounts is dealt with at great length; in fact, as might be expected, the subject in one form or another fills half the book.

This portion of the work reminds us strongly of Garcke and Fells on factory accounts, of which the manufacturing community has shown its appreciation by calling for several editions since its publication in 1887.

Mr. Lewis's system is very elaborate, but none the less admirable; his excellent diagrams of connections make the scheme intelligible at a glance, while the reference numbers (à la Bradshaw's map) enable the reader to turn instantly to the particular paragraphs dealing with each step.

The prime cost account and the establishment and manufacturing charges accounts are explained with great care, and we notice with satisfaction that the scheme includes the keeping of unpersonal ledger accounts for the latter items; the omission of this precaution is a common and reprehensible practice, leading to the use of incorrect averages, which nearly nullify the value of the prime cost account to the estimating department. Prime cost is the bug-bear of engineering works, and even when occasionally correctly kept, it represents only a part of the actual cost of the articles manufactured, it becomes, therefore, a matter of vital importance in fixing the sale price to know the exact amount of general charges incident to each class of goods. We do not, however, agree with the author as to the desirability of attempting to obtain an approximate balance of the ledger account; we prefer to adopt percentages based on the normal output of the factory, and to carry the balance to one side or the other of the balance-sheet, rather than make changes from time to time as conditions vary with the state of trade. In our opinion, the young firm described in Clause 269 would do better by basing their estimates of general charges on the experience of the trade, rather than on their own expenditure; the account would show a loss during the first year or two, but they would get out of shoal water more quickly than by attempting to make the account balance.

It is obviously impossible to present our readers with a description of Mr. Lewis's system of book-keeping; it appears to us to be complete, and better than any we have seen in operation. Samples are given of every book and of every form required to give it effect; we find only one omission, that is an example of its cost stated as a percentage on turnover. This would have been very interesting, and extremely useful as a basis of comparison. Systems always cost money, and some may fairly be termed expensive; but where there is no system, there is no profit, and it must be a good business in these days that will make a profit with an imperfect system of accounts. Probably no part of the author's labours will be more highly appreciated than his arrangement for enabling the public to obtain the account books required, simply by paying for them, without the tedious and interminable toil of educating a printer. (See page 115.)

In conclusion, we have pleasure in recommending this book to the attention of our manufacturing friends, and if they take it up expecting to find much, we shall be greatly surprised if they do not find what they want.

Fortschritte der Elektrotechnik. Zweites Heft and fünftes (Patent) Heft herausgegeben. Von Dr. Kahle. *Jahr*, 1894. Berlin: Verlag von Julius Springer, 1896.

Electrotechnical literature is already very extensive and increases every year almost at a geometrical rate of progression. It becomes therefore every year more difficult for the electrotechniker to know what has been already done on any subject in which he may be interested either as an inventor or a manufacturer. Scientific literature, it appears, is to be amply provided for in the way of indexing by the co-operation of foreign goverments with our own; but this millennium for the scientific searcher which is to commence in 1900, is not to be extended to the seeker for needles in the haystack of technical literature. Though both of these indexes are very urgently required, the technical index would undoubtedly be of more immediate value to the community, and it is difficult to see why it should be left behind. Meantime technical men must rely on private effort for the supply of indexes. Electrotechnical men are fortunate in being able to avail themselves of so complete and convenient a reference book as what has long been known as "Strecker's Fortschritte," but has now apparently been taken over by Dr. Kahle. We have frequently used this valuable index, and have often found the desired reference here, when all other sources have failed to supply it. The "Patent Heft" contains a list of patents relating to electrotechnics granted in England, Germany, and the United States. Though all these countries publish good indexes and abstracts of their own patented inventions, yet their systems are somewhat different, and it is distinctly useful to have subject matter brought under one uniform system, as is done in this volume. No department of indexing could be carried out more easily on a uniform plan than the indexing of patents, and the government who will initiate this movement would gain considerable kudos at a very small cost.

THE BRISTOL TRAMWAYS.

Preliminary Observations by the Tramways Company on the Traction Committee's Report.

The Traction Committee admit that they cannot point to a single instance in which a tramway company has yet agreed to take a supply of electricity from a municipality in this country, but state that in several cases where electric traction is under consideration, and the electric light undertaking is owned by the Corporation, they find it is proposed that the consent of the Corporation should be given conditionally upon the supply being taken from them. The answer to this is that there may be some individual opinions on the subject in the various localities, but the Bristol Committee cannot point to a single instance where any Corporation has passed a resolution to such an effect, or unless accompanied by Corporation ownership of the tramways in question. The committee also speak of "such an arrangement" being in successful operation on the Continent, at Hamburg, Dresden, Geneva, Havre, and Rome. The inference is that in each of these places the municipality supplies the current, and this being correct would make the report misleading.

At Hamburg the Corporation do not own the supply at all, but a firm of contractors who own the lighting concession have a contract with the tramways company in connection with which the lighting plant and electrical apparatus was specially designed. This lighting is done by the five-wire 500-volt system which is not favoured by our Board of Trade, and is totally different from the Bristol electric lighting system. Inasmuch as the Committee do not propose to rip up all the cables laid down in Bristol or to abandon their present machinery, it is clear the circumstances of Hamburg cannot be compared to Bristol.

At Dresden there are two tramway companies, of which only one, a small concern not comparable with Bristol, is supplied by the municipality, the plant in the station, however, being furnished by the contractors for the tramway.

At Geneva the power is furnished by turbines, and the water-power being the property of the Corporation accounts for the current being so supplied. But the facts show that the example is not applicable to the Bristol case because water-power is used, and the installation was specially designed to meet traction work.

At Havre, the Corporation do not own the lighting supply, but, as in Hamburg, a commercial company are the owners of the station, which contains separate and distinct plants for the two purposes.

At Rome again, the supply is not owned by the municipality but by a lighting company. Only 12 cars are running on the tramway, and, therefore, the case is no guide. However, it is astonishing the Committee should cite this as an example for Bristol, seeing Mr. Preece discloses that the current is transported by overhead conductors at 6,000 volts, whereas our Board of Trade restricts tramway currents to 500 volts maximum, and the Bristol Lighting Committee have to bury their 2,000 for safety.

It will thus be seen that the Committee are unable to produce a single parallel case with Bristol, and whilst they have only dealt with the limited area of the Continent and England, no reference whatever has been made in this connection to the United States, where in no single instance is there any precedent, although there are hundreds of tramway companies working electrically.

The Committee further state that at Belfast and Gloucester the taking of the supply from the Corporation was proposed by the tramway companies themselves. The reply is that the Committee have evidently been misinformed, as in answer to the Bristol Company's enquiry the secretary of the Belfast Company states that there is no foundation for this, and that the company has not even discussed the question of supply. In the case of Gloucester, the directors are the same as of the Bristol Company, and can therefore speak with authority. The facts are that the Gloucester Company, having no capital for developments, proposed to sell the tramway to the Corporation who, as owners of the lines, would then have supplied the current by plant designed for the purpose. The suggestion of a sale fell through, and with it the idea of the Corporation erecting traction plant. The Corporation have no lighting establishment as yet.

It is fallacious for the committee to claim that by reason of their having a lighting station they would necessarily be able to produce the current for an extensive tramway system at a cheaper rate than the Tramways Company could generate the current for themselves, and this is a point which the company's electrical engineers, who have great practical knowledge of traction work, will in due course demonstrate most completely.

The committee state that a transition from overhead to accumulator or underground system has been found practicable in Leeds. It is presumed, therefore, that the committee have not yet obtained the information which was published some time ago that the Leeds Corporation have, after careful consideration, abandoned this idea, and have determined to carry the overhead system through the central streets as well as the outside districts. It is significant that the Leeds Corporation, as owners and workers of the tramways, have found such a transition commercially impracticable.

On the general subject the committee arrive at a conclusion that because electric traction can be worked at a cheaper rate per car mile than horse power, the divisible profit of a tramway company must necessarily be greater; but in arriving at this they entirely overlooked the all-important factor that in order to introduce electricity the company's capital has to be more than doubled, and whilst the original capital in the horse tramways is wiped out the dividends have still to be paid on the doubled capital, and as well a sinking fund provided to reinstate within the short term of 21 years the capital so lost, plus a further capital depreciation on a forced sale to the Corporation under the terms of the Tramways Act, and in addition protecting the premium at which the company's capital stands. The effect of this would be that the company's profits would have to be three to four times the amount of the present net revenue, in order to do no more than pay their present rate of dividend.

The statement of these facts shows that the company are undertaking a very heavy task if they are to put themselves right within 21 years from commencing to work their whole system electrically, so that the suggestion of the Committee that the company should in addition come under a liability five years hence at the will of the Corporation to substitute any other system of traction at a third capital outlay, is so obviously impossible that the Town Council is hardly likely to seriously entertain it, if they really desire the company to enter upon a responsibility of such magnitude as is involved in the proposals now before the public.

Offices of the Company,
Clare Street House,
Bristol, *December 1st*, 1896.

Report of the Consulting Electrical Engineer to the Tramways Company.

To the Directors of the Bristol Tramways and Carriage Company Limited.

Gentlemen,—I have considered the report of Mr. W. H. Preece to the Town Clerk of Bristol on the subject of electric traction on tramways. It would be difficult to make an intelligible answer to Mr. Preece's report by taking it up from point to point. However, the fundamental ideas of the report can be sub-divided so that an answer can be easily followed.

I take it that what Mr. Preece has attempted to demonstrate is that:—

(1) The electrical trolley system is the most efficient and useful system.

(2) That the supply of electricity from the Lighting Committee's plant at Bristol can be done more cheaply than by the Tramways Company with such plant as they may construct.

The first point may be inferred from Mr. Preece's report. On the second, however, there can be no misunderstanding as to Mr. Preece's recommendation.

The points that I would bring to your attention with respect to the first proposition, that is, with respect to the fitness of the trolley system for Bristol, are as follows: that both in Europe and the United States it is an accepted fact that the trolley system is simplest, most economical, and, if well constructed, is not æsthetically objectionable in streets; that in case of such narrow streets as Lawrence Hill and West Street, which have been successfully operated by the trolley system for more than a year, the trolley system has not been found objectionable, nor has any necessity for a conduit suggested itself, and I know of no other streets in Bristol which it is proposed to equip that are so congested and generally unfavourable.

With regard to the examples of conduit system instanced in Mr. Preece's report, that of Buda Pesth is exceptional, and for reasons of which you are well aware, open to such objections as render the system unsuitable to this country.

The one at Blackpool is too small to be of any assistance in judging what may or may not be found useful in Bristol.

As to Chicago, Mr. Preece is under a misapprehension, as there is no conduit system and the trolley has been sanctioned to supersede the cable system.

In Washington the conduit system is in use but the conditions at Washington differ widely from those at Bristol, and the system in general has been installed for a short time only. It remains to be demonstrated whether or not it will stand the conditions brought to bear upon it by an American winter or by such conditions of moisture and street traffic as obtain in Bristol.

In New York the conduit system is not considered sufficiently practicable to admit of any further extension. The engineers who installed the first line have advised their directors that a further extension of the present system is not warranted by the facts gleaned from the operation of the present conduit system.

It seems hardly necessary for me to say that I quite concur with the opinion and conclusion of Mr. Preece that the conduit system is not economically practical in Bristol, and that we must consider things as they are.

Taking it therefore as an accepted fact that the trolley system is the one best adapted for the operation of tramways, the remaining point to be considered is whether or not the electricity for such a system can be more economically supplied from a lighting station, such as now exists in Bristol, or from a Station specially designed to meet your requiremeets and specially managed by your own staff.

I shall first consider the experience gained in the United States where both electric lighting and electric traction have been carried on to a very large extent and where both have reached a high state of perfection.

Amongst the most representative cities are Boston, Chicago, and Washingtnn, in which both electric lighting and electric traction may be said to have attained alike prominence and perfection. If you were to ask a manager of either the traction company or the lighting company in these cities whether or not he considered there would be any advantage in consolidating the electric supply for the lighting and tramways systems, you would receive a direct answer that there would be no possible advantage and that there would probably be some disadvantages. These men having had large experience and observation, have seen that the nature of supply is absolutely different. In the case of electric lighting, the supply of energy from moment to moment is practically constant and the desired condition is constant pressure so that the lamps may be kept at a uniform light. In the case of electric traction, the supply of electricity from moment to moment varies greatly. Take your own St. George Station as an example. The power output at one moment amounts to not more than one-fifth the output of the working machinery. A moment afterwards the whole capacity of the working machinery is utilised. To properly supply electricity for a traction system, it requires machinery of much the same nature as that required in a rolling mill in which the load is either all on or all off and from moment to moment.

In the cities above referred to, the lighting and traction generating plants are entirely separate and distinct, as indeed in all other cities in the United States with which I am acquainted; and, as you know, my experience in the States has been very general, inasmuch as much of the machinery in use there has been built from my designs. It is agreed by all authorities there that, owing to the different conditions of supply, there would be no economy and probably a direct disadvantage in supplying both systems from the same plant.

The next statement by Mr. Preece that I desire to bring to your attention is that the reduction of the total cost per unit as the output increases is well shown in the case of Manchester. I admit that this is true in the case of Manchester. The fact remains, however, that all the electricity is supplied for the same purpose, but if the electricity were supplied for two such widely different purposes as electric traction and electric lighting, the opposite would probably be found to be the case. If the same machinery were used for both purposes, either the tramway or the lighting would suffer. It is a recognised fact that incandescent lamps cannot be made to burn steadily in a system where the loads rapidly fluctuate, as in a tramway system.

Taking up specifically the cases mentioned by Mr. Preece where both electric lighting and electric traction plants are supplied from the same station, we will consider that of Hamburg. The machinery was specially designed with reference to a combined lighting and tramways system, and was primarily designed to suit the requirements of tramway system, the lighting system being considered of minor importance. The only advantage gained is that the machines can be interchanged in case of failure; in case one of the tramway machines fails, a certain amount of lighting apparatus can be utilised. None of the machines are, however, used for both purposes at the time.

You will see that such an arrangement as this offers no precedent for Bristol, since the lighting machinery now installed could not in any case be used in place of the machines required for the electric traction work. The two plants would have to be separate and distinct, as is admitted by Mr. Preece. In each plant there would have to be the same margin for over-loads, short circuits and emergencies; since in the case of emergencies neither plant could be utilised to assist the other. Even in the case of the Hamburg arrangement it has not been demonstrated that there is any increased economy resulting from the supply of electrical energy for both lighting and traction purposes from under the same roof; and as illustrating the feeling of the Tramway Company with reference to the use of a plant not controlled by themselves, I may refer to the company's last annual report stating that "We could have transported even more people if the Hamburg Electricity Works would have kept pace with us in their progress."

I would further point out that the differences that exist between England and Germany in the price of labour make comparisons of cost altogether misleading. The average wage of a motorman in such a system as that at Hamburg is about 18s. per week, whereas your motormen of the St. George line receive 30s. a week, and, as you know, the item of labour in connection with tramway work is the principal one to be considered.

With respect to the cases of Dresden, Geneva, Havre and Rome, I have already furnished you with information which you have published, showing their total inapplicability to Bristol.

An additional feature which occurs to me with regard to Rome, is that the storage batteries for bridging over the interval in the evening although only for 12 cars, involve a weight of lead amounting to 100 tons, and such an arrangement for Bristol would necessitate the provision by the Lighting Committee of 1,500 tons of lead in batteries!

It cannot be too strongly impressed that there does not exist at the present time such an installation as Mr. Preece suggests as practicable for Bristol. His load diagrams seem to show that the maximum loads overlap, though as to this uniformly occurring I cannot agree with him, since the maximum load of the tramway company may or may not occur at the time suggested by Mr. Preece. The maximum loads occur on certain days, that is, holidays and Saturdays, and not at certain hours of any particular day. The two maximum loads may, however, occasionally happen at the same time. In tramway experience it has been found most economical to provide for these maxima by a proper margin in the generating machinery and storage batteries in large systems are not considered economical or practicable. In some lighting installations in Germany storage batteries have been found practicable and economical for lighting purposes. If, as Mr. Preece suggests, the modern accumulator eliminates the possibility of a breakdown or renders one independent of the machinery at a breakdown, why have these not been installed at Bristol so that in case of a breakdown of the alternators these accumulators could take up the load? In the system as now installed this provision has not been made, having regard either to economy or emergency, and for the very reason that the installation at Bristol is not supplied with such machinery as permits of economical storage nor of the supply of energy for an electric tramways system. I would point out to you that a system of storage in connection with the present lighting machinery would be both inefficient and expensive. Synchronous motors of the same capacity and cost as the alternators now used, as well as dynamos of approximately the same cost, would be required in connection with storage batteries. The efficiency of such a system would then be only about 70 per cent., as against 100 per cent. when the electricity is delivered direct to the consumer's circuits, as you are proposing to do in connection with your tramway work.

There are other points to which I would draw your attention. First, with respect to Mr. Preece's load diagrams. The amount of power he proposes is altogether insufficient for the number of cars upon which he bases his calculations. Mr. Preece states your car stock at 100, as a fact it is 124. He estimates it will be increased to 150, which I accept in my estimates of power required. Mr. Preece proceeds to state the daily average run per car at 70 miles, whereas, from your own experience at St. George's, you know that not less than 100 miles is the regular practice. Again, for some inexplicable reason, Mr. Preece takes 300 days per annum instead of the 365 known to tramway managers, the result being that his mileage for one car amounts to 21,000 per annum, as against 36,500 which is the fact, an error on Mr. Preece's part of no less than 75 per cent., which, multiplied over the 150 cars, gives a similar mistake in the quantity of electricity to be consumed, so that instead of the 3,150,000 units per annum of Mr. Preece, you would require 5,475,000 units, even assuming for the moment that one unit per car mile would be adequate, having regard to the difficult gradients in Bristol. You will appreciate the magnitude of this miscalculation when I remind you that the error represents four times the total quantity generated last year by the Bristol Corporation Electricity Department.

Equally so with reference to the generating plant estimated by Mr. Preece as sufficient for the tramway purposes, you are aware that I have already advised you that it would be necessary to instal plant of approximately twice that capacity.

Further, Mr. Preece himself, while recommending a distinct electrical plant, claims that the staff would be common. Considering, however, the differences in the machinery and the different conditions of supply, a separate staff would be required for each branch.

I have already pointed out the inefficiency of any storage system as applicable to the Bristol alternators, and it follows therefore that there would also require to be provided a full complement of engines, boilers, &c., for each business.

Where, then, with duplicate machinery, duplicate staff, and absolute lack of interchangeability, can there result any economy?

I do not agree with Mr. Preece's statement that three or perhaps four central stations would be found necessary in Bristol, inasmuch as one central station properly situated will be entirely sufficient for your purposes.

With regard to Mr. Preece's criticism of the location of your St. George Station, I may point out that the district served is an outlying one, and the station is favourably placed to enable you to comply with the requirements of the Board of Trade restricting the drop in the earth return to 7 volts. The location of that station is also advantageous in view of your contemplated operation of the Old Market and Staple Hill line from that source.

Considering finally Mr. Preece's closing statement, he has not demonstrated that the cost of production per unit will be reduced by the arrangement proposed by the Lighting Committee. Considering

the wide differences in the nature of supply of electricity for an electric traction and an electric lighting system, the combination of two such systems of supply would divert the attention of the electric lighting engineers from their legitimate field, and render the supply of electricity to both consumers uncertain or unsatisfactory, since a special knowledge and a special staff are required for the proper carrying out of either branch of the work.

As your engineer, I should strongly advise you not to hazard the success of the entire business of your Company by undertaking to extend the system of electric traction in Bristol, if accompanied by a condition that you are not to be permitted to generate your own supply of electricity.—I am, Gentlemen, yours very faithfully,

HORACE FIELD PARSHALL,
M.Inst.C.E., M.Inst.E.E.

London, *December 2nd*, 1896.

OPINION OF DR. JOHN HOPKINSON, F.R.S. PRESIDENT OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

To the Directors of the Bristol Tramways and Carriage Company, Limited.

GENTLEMEN,—I have carefully considered Mr. W. H. Preece's Report to the Bristol Corporation Electric Lighting Committee and Mr. Parshall's Report to the Directors of the Bristol Tramways Company, and I fully concur in Mr. Parshall's recommendation, viz, that you should not extend electric traction in Bristol unless you are permitted to generate your own supply of electricity.

In my capacity as an adviser to Municipal Corporations, I have given the question at issue some study, and have no hesitation in advising that in the particular circumstances at Bristol, the Corporation cannot possibly supply the current to the Tramway Company as cheaply as the Tramway Company can generate it for themselves.

The Tramway Company would be ill-advised in entering upon such a dual arrangement as that suggested by the Lighting Committee's Adviser, for I am convinced that such an arrangement would result in serious disadvantage to both parties.

I am, Gentlemen, yours truly,
(*Signed*) J. HOPKINSON.

Westminster Chambers,
5, Victoria Street, S.W.,
December 5th, 1896.

OPINION OF LORD KELVIN, D.C.L., PAST PRESIDENT OF THE ROYAL SOCIETY.

I have read Mr. Preece's Report to the Lighting Committee of the Bristol Corporation and Mr. Parshall's reply to the Bristol Tramways and Carriage Company. I agree with Mr. Parshall that the present Bristol plant is altogether unsuited for the supply, or for economically contributing to the supply, of the Tramways system. The supply of an electric tramway system in conjunction with a lighting system could not in my opinion be realised with good economy under the conditions obtaining at Bristol. The Tramway Company having already had more than a year's practical experience in the use of electric traction on a part of their lines, are well qualified to judge of their needs for the whole, and considering all the circumstances, I am strongly of opinion that the Corporation of Bristol cannot do better than leave the Tramway Company free to arrange its own plans for generating, supplying, and using electricity for its traction.

(*Signed*) KELVIN.

Glasgow, *December 5th*, 1896.

PROCEEDINGS OF SOCIETIES.

The Northern Society of Electrical Engineers.

ON THE MANUFACTURE OF ALKALI AND BLEACH BY CHEMICAL AND ELECTROLYTICAL METHODS. Paper read by BERTRAM BLOUNT, F.I.C., F.C.S., Assoc.Inst.C.E., December 7th, 1896.

(*Concluded from page* 780.)

At this stage of the paper, it appears not without value to transcribe certain calculations of cost of decomposing chlorides of the alkali metals electrolytically made by the well-known German electro-chemist, Dr. Borchers, and published recently in the *Zeitschrift für Elektrochemie*. He takes, in the first place, the cost of an electrical horse-power for the year, working day and night, at £4 when water power is available, and at £8 15s. to £20 when coal has to be used. This corresponds with about 0·09d. and 0·24d. to 0·55d. per horse-power-hour. It is probable that the cost of water power is here under-estimated, and in any case it is not of primary importance in this district. The lower value for steam power may be accepted as a basis for calculation. Each electrical horse-power year, working with theoretical current efficiency but with a voltage of 4 volts (of which more anon), will decompose 3·5 tons of salt, having a value of about £2 15s., and will produce 2·4 tons of caustic soda worth £19, and rather over 2 tons of chlorine, which, as chloride of lime, is worth £35. The production of the latter material involves the consumption of 3·2 tons of lime, costing £2 8s. Therefore, from raw materials costing in all £5 3s., and by the expenditure of power costing £8 15s., products can be obtained having a market value of £54. An outlay of £13 18s to gain £40 2s. is certainly tempting to the speculator.

Making a similar comparison for some of the best known processes proposed or put in practice in this country, values are obtained which, if not quite so attractive, at least offer a large enough margin for profit. Thus the Castner-Kellner process is credited by its devisers with a current efficiency of 88—90 per cent., so that assuming it can be worked at the same pressure as that chosen above (4 volts), and taking the same buying and selling prices for the raw materials, and the products, chloride of lime and caustic soda, the expenditure will be £13 5s., and the net profit £35.

In the case of the Hargreaves-Bird process the preference of the patentees is for the manufacture of sodium carbonate rather than for that of caustic soda, and the estimates have to be modified accordingly. The current efficiency claimed is 80 per cent., and the pressure said to be required is 3·4 volts. Accepting these, an expenditure for raw materials and power of £13 12s. yields a profit on the sale of the finished products (soda ash and bleach) of £39 9s.

Others could no doubt be quoted giving on paper profits almost equally seductive. That such profits have hitherto proved hard to realise is due to the causes already indicated in an earlier part of this paper, viz., the high cost of the plant per unit of output, and its considerable deterioration in use. Another cause may be touched on here. It must not be supposed that both chief products of electrolysis, caustic soda and chlorine, separate neatly and completely from the electrolyte in which they have been formed. Their combination, with the production of salts of various acids containing chlorine and oxygen, is apt to occur if the diaphragm be in any degree too porous, or if electrolysis be pushed so far that the liquid in the cathode department is even moderately rich in caustic soda. The inconvenience of allowing the liquid in the anode compartment to remain saturated with chlorine can scarcely be avoided, as the only practicable means of prevention, viz., keeping the electrolyte hot, is not to be thought of on other grounds altogether. When once saturation has occurred, however, the further quantity of chlorine evolved escapes spontaneously, and can be sent direct to the bleaching powder chambers. But with the caustic soda a definite method of recovery is needful. According to the practice generally adopted in most processes, brine is circulated through the anode and cathode compartments independently, and fresh salt added as the strength of the liquor declines.

It may be taken that the most concentrated solution of caustic soda that can be profitably prepared in an electrolytic cell contains not more than 10 per cent. of the solid substance NaOH. With this is associated a large quantity of undecomposed salt, and the recovery of the latter is a necessary concomitant of the isolation of the former. Fortunately the majority of sodium salts are insoluble in a concentrated solution of caustic soda, whence it happens that on boiling down a weak solution, separation of sodium chloride takes place progressively, and the separated salt can be fished out. There should be no serious difficulty in ultimately preparing caustic soda containing no greater quantity of foreign salts than does the best grade of caustic soda now put on the market, viz, that known as "77 per cent.," which is approximately pure NaOH. It is true that a considerable quantity of caustic soda will cling to the salt fished out; but this is only a source of loss, in so far as it represents a certain amount of marketable material locked up in the process, and necessitates the addition of a small sum in the reckoning of interest on the whole stock. The caustic soda held in this way is not lost, but returns with the recovered salt to the cathode compartments. Processes such as the Castner-Kellner, using mercury as an intermediate electrode, have the advantage of obtaining caustic soda in solution free from salt, and the necessity for separation does not arise.

I have said nothing as to the production from fused salt of chlorine and sodium (and caustic soda from the latter by the action of water), because the mechanical difficulties of constructing an apparatus capable of withstanding the attack of sodium chloride at a red heat have hitherto proved of the most formidable kind, and although gallantly encountered both in this country and abroad have, as far as I know, not yet been overcome. It is enough to say here that any process of the sort will always be handicapped by two circumstances: (1) the necessity for supplying energy in some form to keep the electrolyte fused, and (2) the waste occasioned by the need for expending energy sufficient to win sodium itself instead of caustic soda, that balance of energy being wasted as heat when the sodium is brought into contact with water for the production of caustic.

Any review of the subject of the electrolytic production of alkali and bleach would be imperfect without a section devoted to the consideration of the merits of the plan of manufacturing caustic potash in place of caustic soda. Suppose it be conceded to those who deny that the formation of caustic soda electrolytically is likely to be profitable, that the prospects of success are not altogether assured, it may at least be possible to contend that a better fate attends the manufacture of caustic potash. Happening as it does that potassium is less widely and abundantly distributed in the earth's crust than is sodium, and that certain compounds of potassium cannot be industrially replaced by sodium, it follows that the price of potassium salts is higher than that of corresponding sodium salts, and is likely to continue so. Gunpowder is still a primary necessity of civilisation, or, perhaps, one should say a standing need of peoples not yet initiated in the mysterious charms of smokeless explosives, and its manufacture is carried out on a large scale. Again, it is clear that a period of national rejoicing cannot be celebrated in a convincing manner without the aid of the artist in pyrotechny. To what sorry plight would both be reduced if denied the use of potassium nitrate and chlorate? In all seriousness there are many considerable manufactures—of which the preparation of soft soap and of oxalic acid may be mentioned—in which the use of potash as distinct from soda is a *sine quâ non*. How with a valuable raw material such as potassium chloride, the cost of the energy and labour impressed upon it is a smaller fraction of the whole cost of the finished product than is that of the energy and labour spent

upon a cheaper material, *e.g.*, sodium chloride. Losses of the raw material at any stage of its conversion consequently have a greater monetary significance, and a process operating cleanly and in a manner economical of the material handled will have an advantage which may outweigh any extra expenditure of energy. An estimate similar to those already quoted is available for the case in which potassium chloride instead of sodium chloride is electrolysed. Using the same data as before and assuming a theoretical current efficiency and a voltage of 4 volts, one electrical horse-power year would produce from 4·4 tons of potassium chloride and 3·2 tons of lime, 3·3 tons of KOH and 5·2 tons of chloride of lime. The cost of the power is £8 15s., that of the potassium chloride at £7 per ton is £31, and that of lime, £2 8s., while the value of the products, reckoning caustic potash at £26 per ton, and chloride of lime at £6 15s. is £86 and £35 respectively, representing a gain of £79 on an expenditure of £42. Of this expenditure the fraction which has to be incurred in buying raw materials by any process whatever is $\frac{1}{2}$ths, so that it is obvious at a glance that economy of raw material is of greater importance than is cheapness of handling. Translating these figures into something which is not beyond practical attainment, *i.e.*, assuming a current efficiency of 80 per cent., and using as before a voltage of 4 volts, an expenditure for raw materials and power of £35 would yield products representing a gain in value of £62. Of the expenditure, the fraction representing the cost of the raw materials is $\frac{2}{3}$, so that the position is almost as favourable as when the theoretical current efficiency is assumed.

Perhaps the most promising of all processes for preparing by electrolysis one of the products of the alkali trade is that for the manufacture of potassium chlorate. The apparent simplicity of the requisite reactions is most enticing. On electrolysing a solution of potassium chloride, caustic potash and chlorine are to be expected as the first products. If then no attempt be made to separate these products, but, on the contrary, the cell be provided with a good agitator, they will unite to form potassium hypochlorite if the solution be cold, and potassium chlorate if it be hot, according to the equation

$$6\,KOH + 6\,Cl = KClO_3 + 5\,KCl + 3\,H_2O,$$

$\frac{5}{6}$ths of the total potassium concerned in the reaction reverting to the condition of chloride. It must not be supposed that this reversion represents an avoidable waste; the chlorine which, for clearness of argument, may be regarded as liberated in the first stage of the electrolysis, is fully represented by oxygen in the ultimate product, potassium chlorate. In existing chemical processes the reaction between chlorine and an alkaline substance is carried out with lime instead of potash, and potassium chlorate is prepared by double decomposition with potassium chloride. Therefore, under these conditions, $\frac{5}{6}$ths of the chlorine is actually run away as calcium chloride —another example of the typical defect of most chemical processes, viz., the production of a large quantity of almost worthless bye-product. It is difficult to say how far the manufacture of potassium chlorate by electrolytic means is carried on at the present time. Somewhat florid accounts occasionally reach us from the Continent and the United States, but thoroughly reliable information cannot be readily obtained. The manufacture has either failed to attract attention in this country, or possibly is being quietly pursued with a profit which would shrink if competing makers were aware of its successful working.

There are certain general considerations on which it may not be superfluous to insist in summing up the present position of the manufacture of alkali and bleach by chemical methods and by electrolysis. In the first place it is customary and necessary to state the current efficiency of a process, that is, the output of the desired product as compared with that calculated from the ampere-hours. This is desirable, because the efficiency of the cell in keeping separate the products of electrolysis and of allowing of their isolation in a marketable form is thus ascertained, irrespective of all question of internal resistance. But the efficiency thus stated is not the energy efficiency of the cell. A cell with a given current efficiency may be working at a pressure of three, four, five, or six volts, and the energy efficiency of the last will be just half that of the first, in spite of an identical current efficiency. The total number of heat units represented by the conversion of a given raw material into given products under known conditions can be calculated from existing thermo-chemical data with a fair degree of precision; the total number of units of electrical energy passing with a known current at a known voltage can be stated with accuracy; the number of units of electrical quantity concerned with the fulfilment of a given reaction is also known; the minimum voltage which will accomplish the decomposition can therefore be calculated fairly closely. Thus when sodium chloride in solution is converted into gaseous chlorine and caustic soda in solution, about 53 Cal. are required for 1 grm. equivalent of NaCl. The smallest pressure at which electrolysis can be effected is therefore 2·3 volts. But the lowest voltage yet claimed for any process producing caustic soda and chlorine is 4 volts, whence we see that an electrolytic method needing this voltage and having a current efficiency of 80 per cent. has an energy efficiency of only 46 per cent. I do not say that full efficiency can be readily attained, but I do say, without hesitation, that it is above all things requisite to keep the calculated limit steadily before us both in judging or comparing processes and in seeking to devise improvements on such methods as exist. It is well to realise—and a considerable amount of iteration in enforcing it may consequently be pardoned—that there is a margin of some 50 per cent. at the disposal of the electro-chemist intent on improving extant processes for the industrial decomposition of common salt. This possibility has been overlooked or intentionally ignored by those concerned with the exploitation of particular processes and not unnaturally anxious to put the most favourable construction possible on the performance of their pet cell, but the attitude of mind thus induced is about as reasonable as that of the copper smelter who prefers the old and inaccurate Cornish dry assay to exact modern methods of analysis, because the former deals lightly with the imperfections of the smelting process, not to mention his own technical shortcomings.

A precise quantitative comparison of the merits of the chemical and electrolytical methods of preparing alkali and bleach, is obviously impossible at the present time; were it possible, every maker would be using one or the other and the *raison d'être* of this paper would disappear. But it is practicable to sum up the weak and strong points of the two processes in a qualitative sense.

The electrolytic process is direct, cleanly, economical of labour, free from worthless bye-products. Per contra, its units of plant are small, troublesome, costly, and quickly deteriorated by use.

The chemical process can provide a large output with comparatively few units of plant, of, on the whole, simple construction and of large size; repairs, though heavy, are not numerous, nor have they to be applied to a vast number of small apparatus. On the other hand, much arduous and fairly skilled labour is requisite, and bye-products valueless or of negative value are invariable concomitants.

It is ill work to prophesy. I, for one, decline the ungrateful *rôle* of a seer. But this may be said: That with the advent of tolerably permanent plant, even with the present low energy of efficiency, electrolytic processes will push existing chemical methods hard. When this happens, chemical manufacturers may set to work with even greater vigour than heretofore to economise and improve, and I, for one, do not think that they have yet come to the end of their tether. In the absence of a vaticinator we must be content to await the issue.

The Société Internationale des Electriciens.

At the meeting held on December 2nd, M. Violle made a few remarks on the platinum luminous standard, with reference to various discussions on photometric subjects that have taken place at Geneva. He called attention to the fact that in order to get a fixed unit we must have recourse to a fixed phenomenon. The fusion of pure platinum always takes place at the same temperature, and thus we get a well-defined luminous source, that is, if certain precautions are taken with regard to the preparation of the platinum. Various experiments made by M. Leblanc, M. Monnier, and M. Carpentier, have brought out these results clearly.

M. Hillairet then, in the name of the Administration of the Society, made a general review of mechanical traction at Paris. He showed that the present means of transport are absolutely insufficient. With 290 millions of passengers per annum in Paris, there are only 300 millions of places offered. The new modes of traction brought out to remedy this state of affairs are numerous; but for Paris we must choose a mode of traction capable of adapting itself to all the requirements of this city. We already have in Paris systems of traction with steam locomotives on the Boulogne line and on various other lines, with Howall cars and Serpollet cars. There are also tramways worked by heated steam on the Franck system, on the Etoile line at Courbevoie and at St. Germain. Compressed air is used in the Mekarski cars on the line from Vincennes to St. Augustin, and on the Boulogne line. This system does not give a very high efficiency and we must reckon a mean expenditure of 5 to 6 kilogrammes of coal per car kilometre. The gas tramways are interesting, but they involve a great deal of mechanism; they offer no advantage from an economical point of view in Paris on account of the high price of gas, which costs ·30 fr. the cubic metre. In electric traction the trolley system is the simplest and the easiest to instal. It offers, however, certain difficulties in its installation. The tramways with ground contacts, one example of which exists in Paris, the Claret-Vuillemeier tramway, seem to lend themselves very readily to the requirements of a large town. The tramways worked by an underground conduit are also very suitable, but the cost of first establishment is very high. In Paris we must reckon it from 4 to 500,000 fr. per kilometre. This capital can, however, be regained under good conditions. Lastly, we have to consider the accumulator tramways, which must not be overlooked, and which have been used in Paris since 1892. These can be worked in two ways; the cars can return to the depôt for the accumulators to be recharged, or they can be recharged *en route* by being branched on the trolley. The latter course involves a mixture of methods, requiring the accumulators to work the car within the town and the trolley to start it outside the town.

After a few remarks from Messrs. Dieudonne and Regnard, the discussion was postponed until the next meeting.

PAPER FRICTION WHEELS.

The advantages of paper for friction wheels were recently set forth in a paper by Mr. W. F. Goss before the American Society of Mechanical Engineers. Doubtless some of our readers have used friction wheels in which the driven wheel was cast-iron and the driver was gun-metal. In this combination, should slipping take place, there is every chance of wearing a flat place on the driven wheel, and when a flat place has been once worn it is very difficult to obtain satisfactory working. If at any time a heavy duty is being done the wheels will slip when that flat place comes round, and further movement is then impossible. We have fought with this difficulty and know it, and can therefore endorse what Mr. Goss advances as to the importance of having the driving wheel of a much softer and more yielding material than the driven wheels. Mr. Goss names such articles as wood, raw hide, leather, or India-rubber, but states that light work only was possible with these. But a new material—compressed strawboard—seems to be very suitable. Friction wheels of paper are

built up of thin discs of strawboard cemented together under heavy pressure and strengthened by iron side plates. The edges take a good finish when turned, and work perfectly against cast-iron. To determine the co-efficient of friction of the surfaces experiments were made with paper wheels of 5½, 8, 12 and 16 inches diameter driving a 16-inches diameter wheel of cast-iron. The contact pressure could be varied between 75 and 400 lbs., and the speed of the surfaces from 450 to 2,700 feet per minute.

It was noted that by a gradual increase of the duty slipping could be increased up to 3 per cent., but that if by care the slip could be got up to 6 per cent. it was apt to run rapidly to 100 per cent., or in other words, the driven wheel would stop. Three per cent. would seem, therefore, to be an allowable limit of slip. In fact, the co-efficient of friction increased up to this percentage of slip. Up to 2 per cent. slip the coefficient of friction was noted at 25 per cent. as a maximum, while even higher values were given at a slip of 3 per cent. The coefficient is constant up to 150 or 200 lbs. of contact pressure per inch of wheel face. At 400 lbs. pressure it is 10 to 15 per cent. less than at 150 lbs. The wheels of 8, 12, and 16 inches gave the same value of friction, while a 6-inch wheel gave about 10 per cent. less. Between 400 and 2,800 feet peripheral velocity the coefficient of friction does not show any variation. While there is not length of experience to show the life of the paper wheels under pressures of 400 lbs. per linear inch of face, it is, perhaps, best to work at the pressure of maximum coefficient, namely, at 150 lbs. Hence is derived the formula for the horse-power.

$$\text{H.P.} = \frac{150 \times 0{\cdot}2 \times d\,\pi \times \text{W} \times \text{N}}{33{,}000 \times 12}$$

where the coefficient is taken at 0·2, d is the diameter in inches, W the width of face in inches, and N the turns per minute. Reduced to simplest form we get H.P. = ·0C0238 d W N, it being understood to apply to diameters above 8 inches, and to fairly clean surfaces. Thus, for a friction pulley of 1 foot by 6 inches wide at 600 revolutions, the horse-power transmitted will be fully 10, and means would need to be provided to put a pressure of 100 lbs. on the working faces. This pressure must also come upon the bearings, and suitable provision of area must be made.

YOKED TO THE CATARACT!*

Niagara's Energy Ready to Stir the Wheels of Buffalo's Great Industries—Power Transmitted Successfully at Midnight Last Night.

NOW FOR PROSPERITY FOR GREATER BUFFALO.

Over 27 Miles of Wire the Captive Power was Carried and Handed to the Buffalo Railway Company to Propel whose Cars it may be Used To-night.

Test was Successful.——How the Current Travelled.

Charles R. Huntley's eye was on his watch and everyone's eye was on Mr. Huntley. The little group in the south-west corner of the Buffalo Railway Company's power-house surrounded two rotary transformers. Just as his watch showed the presence of to-day, Mr. Huntley gave the word. Engineer W. L. R. Emmet shoved down three knife-blade switches. Perhaps two seconds elapsed. Electrical experts say the time was incapable of computation. It was the journey of *God's own lightning bound over to the employ of man.* In the power-house at Niagara Falls three switches had been thrown at the same instant. From the electrical generators of 5,000 horse-power each leaped the current at a pressure of 2,200 volts. Passing through the step-up transformer it passed out on the wires at a voltage of 10,700 volts, and at this strength ran the race over the 27 miles of cable which carry it from the Falls to Buffalo. Entering the transformer house of the Cataract Power and Conduit Company, it was seized by a step-down transformer which changed it to a current of 440 volts and tossed it over to the power-house of the Buffalo Railway Company, fulfilling its contract for 1,000 horse-power at $36 per horse-power per annum.

Here it encountered another transformer, this time the ordinary rotary transformer which issued it as a 550-volt current of the sort that is used to propel trolley cars. From here it passed to the wires of the Buffalo Railway Company to move its cars.

Preliminary Test at 9 o'clock.

It is said to have been in deference to the wishes of the father of Secretary William B. Rankine that the power was not turned on until the workaday week had begun. Nevertheless, the electrical experts worked all Saturday night and all day Sunday trying the various pieces of the system that it might be sure of successful operation once the current was liberated.

The transformers were tried again and again, and the various engineers assured each other that there was not a hitch in the arrangements.

Indeed, shortly after 9 o'clock the engineers made a preliminary test for their own security. The switches were thrown, and the current spurted over the system, passing lightning-like through the transformers and manifesting itself in the swift revolutions of the big converter. Satisfied by this test, the engineers waited for the official test at 12 o'clock. Among those present at that time were George Urban, jun., president of the Cataract Power and Conduit Company; Charles R. Huntley, vice-president and general manager; Mayor E. B. Jewett, H. H. Littell, general manager of the Buffalo Railway Company; Henry M. Watson, president of the Buffalo Railway Company; President S. S. Kingsley of the Board of Trade; Frank S. McGraw, George H. Dunbar, Clarence M. Bushnell, Henry S. Hill, and Thomas H. Fearey.

Full Power in 4½ Minutes.

Within an incalculable period after the throwing of the switches the coil of the transformer was buzzing, first with slow revolutions which quickened with each instant until a shower of sparks flew from it and the buzzing sound deepened to a roar. There was no trembling, no quavering, just the roar of the swift revolutions of the big coil. The ammeter ran up rapidly. In two minutes it registered 350 volts, and in just 4½ minutes the ammeter showed 550 volts, the current strength that is used in street car service.

The converters used did not arrive until late yesterday morning on account of the breaking down of a car near Syracuse. They were hastily put up, but worked well.

The transmission wires enter the transformer house, carrying the electric energy at a pressure of 11,000 volts, and the two transformations of the power are accomplished by the static transformers of the Cataract Power and Conduit Company and the rotary transformers of the Buffalo Railway Company.

When the power was in motion on the wire, Engineer Emmet made this statement explanatory of the system:—

The System Described.

"The transmission line is connected to the large generators at Niagara Falls, through step-up transformers, two in number, of 1,200 horse-power each, which transform two-phase currents at 2,200 volts into three-phase currents at 11,000 volts. These transformers, as well as the ones in Buffalo, are so arranged that they can be used with a line voltage of 22,000 instead of 11,000, when desired. This change will quadruple the capacity of the line wires now in operation.

"In the Buffalo Railway Company's power house there are three step-down transformers installed in a separate room outside the power house. These transformers change currents from the 11,000 volt line to three-phase currents of about 350 volts between conductors, this being the pressure suitable for conversion into the direct current at 550 volts.

"Switches connect these transformers with the rotary converters. These converters revolve at a speed exactly synchronous with that of the generators, and change the three-phase current received from the step-down transformers into a direct current at 550 volts, suitable for use on the Buffalo company's lines. They will be connected to these lines in parallel with the existing generators, so that the cars can be operated either by steam alone, by Niagara power alone, or by both together.

"In order that transformers of large size may be economically constructed, it is necessary that some means of artificial cooling be adopted. In the present case the transformers are cooled by circulation of currents of air, forced into a chamber below the transformers by centrifugal blowers made by the Buffalo Forge Company. Air passes through the transformers, and carries away the requisite amount of heat.

"The rotary converters have a capacity of 500 horse-power each. The step-down transformers are of suitable size for operating them at full load. The transformers at Niagara Falls are very much larger than is necessary to run the existing rotary converters, they being of the size which will be adopted as the standard unit for future developments, viz., 1,250 horse-power for each transformer. That is, four transformers will be required to take care of the whole out-put of one of the large generators."

Only one Contract for Power.

The Buffalo Railway Company was the only concern with which the Cataract Company had a contract for the delivery of power, for it did not care to make any large number of contracts until sure of the success of transmission, without a large percentage of loss of power, and sure, too, of the cost per horse-power. The price will be $36 a year per horse-power.

Now that the power is here, applications for its use may be expected at once. Its contract with the city did not call for the delivery of power until next June. The company must be prepared to furnish 10,000 additional horse-power every year. The cables now laid will carry 40,000 horse-power, and the new turbines and generators, when in place, will produce 50,000 horse-power.

Not in Use To-day.

After the power had been exercised on the wires for an hour last night it was shut off, and the men whose work had been completed retired to celebrate.

Just when the power will be turned on to run the lines of the Buffalo Railway is not known. It may be done to-night. The company wants to test it in various ways before trusting part of its system to the new power.

How it Started.

Secretary Rankine Released the Electric Current for the Race.

Special to The Enquirer.

Niagara Falls, November 16th.—At one minute after midnight last night the first instalment of Niagara power was sent to Buffalo over the transmission line, and the hopes and anticipations of months were realised. The officials and electricians at the big power-house were busy all day Sunday preparing for this great stride in electrical innovations which will mark the beginning of a new era in the manufacturing interests of Buffalo and this city. At one minute after 12 o'clock all was in readiness for the test, and as the switch

* From the *Buffalo Enquirer*, November 16th, 1896.

was thrown open power coursed over the line to Buffalo. There was a great demand for admission to the power-house early in the evening, and after the invited guests arrived it became necessary to lock the doors.

In the power-house were Secretary W. B. Rankine, Resident Engineer W. A. Brackenridge, the Hon. W. Caryl Ely, Electrical Superintendent Paul M. Lincoln, and Albert H. Porter. Mr. I. R. Edmands, of the General Electric Company, was in charge of the transmission house. A few minutes after 11 o'clock, Messrs. Rankine, Brackenridge, and Lincoln mounted the raised platform in front of the switchboard in the power-house, and arranged the switch. This occupied several minutes, and when it was completed Mr. Brackenridge sent word to Mr. Edmands in the transmission house that the electricity was ready for the transformers, and a minute later the switch was thrown and power was coursing through the transformers and along the line to Buffalo. Then back came the current, and Mr. Edmands pronounced the machinery to be all right, and turned it over to Mr. Brackenridge for the power company.

Communication was had with Buffalo and word was sent back that the Buffalo Railway Company was ready for power, upon which Mr. Rankine stepped to the switchboard, threw the lever, and opened the gates of greater prosperity for Buffalo.

Not a hitch occurred, and everything went off with a smoothness beyond the expectancy of the officials themselves.

Dynamo No. 1 was the one used in sending the electricity to Buffalo last night. Mr. Rankine is loud in his praise of the White Crosby Company, the contractors and engineers who built the transmission line. The line was turned over to the power company all complete last Saturday morning, and the successful transmission of power last night proves the efficient manner in which they did their work.

The current was ready for transmission to Buffalo at noon yesterday, as the terms of the contract stipulated it should be, but Mr. Rankine thought it best not to turn on the power until Monday morning.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1896.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

27,167. "Improvements in electrical batteries." C. E. O'Keenan. Dated November 30th.

27,188. "Improvements in or relating to electro-mechanical indicating and recording apparatus." C. E. Vernon and A. Ross. Dated November 30th.

27,195. "Improvements in electrical switches." J. Gutmann. Dated November 30th.

27,207. "Improvements in the electric ignition of charges in explosive engines." E. J. Pennington. Dated November 30th.

27,209. "Improvements in dynamo-electric machines." W. B. Sayers, H. A. Mavor, W. A. Coulson, and S. Mavor. Dated November 30th.

27,227. "An improved method of lighting pianofortes by electricity." K. B. Ryan. Dated December 1st.

27,262. "An improved primary element with interchangeable electrodes and regenerable positive electrodes." O. Rothmund, E. von Burgwall, and L. Ofenschusse. Dated December 1st. (*Complete.*)

27,265. "Improvements in incandescent electric lamps." G. Davis. Dated December 1st.

27,284. "Improvements in magnetic separators." V. I. Feeny. (J. B. Hamilton, United States.) Dated September 1st. (*Complete.*)

27,301. "Improvements in electric furnaces." E. F. Price. Dated December 1st.

27,304. "Improvements relating to electric arc lamps." W. R. Ridings and J. H. Crawford. Dated December 1st.

27,323. "Improvements in electric arc furnaces." The Acetylene Illuminating Co., Ltd., and P. C. Day. Dated December 1st.

27,344. "An improved mode of mounting filaments in electric glow lamps." J. A. Sinclair. Dated December 1st.

27,353. "Improvements in driving apparatus and gear for electrical road or other vehicles." E. W. Bonson. Dated December 1st.

27,354. "An improved electrical switch for power or traction purposes." E. W. Bonson. Dated December 1st.

27,364 "Improvements relating to safety fuses or fusible cut-outs for electrical circuits and to switch s connected therewith." J. W. Ewart and L. J. Steele. Dated December 1st.

27,376. "Improvements in or relating to electric joints for suspending or supporting electroliers or the like." W. Wilson. Dated December 2nd.

27,397. "Improved switch operating apparatus." L. Turnock. (R. Turner, United States.) Dated December 2nd.

27,438. "Improvements in or relating to the application of electric propulsion on railways and tramways." L. Vojacek. Dated December 2nd.

27,446. "Improvements in electrical resistances." R. E. B. Crompton. Dated December 2nd.

27,449. "Improved means or apparatus for igniting and extinguishing gas from a distance by means of electricity." J. D. C. Chateau. Dated December 2nd.

27,464. "Improvements in electrically driven wool shearing or hair clipping machines." G. Bowmar. Dated December 2nd.

27,482. "Improvements in the insulators of electric lampholders." A. Watson, jun. Dated December 3rd.

27,511. "Improved holder for telephone receivers." E. J. Hartshorn and A. Jowitt. Dated December 3rd.

27,558. "Improvements in electrical signalling apparatus for railways." W. Andrews. Dated December 3rd.

27,578. "Improvements in alternating current dynamo-electric machines." J. W. Ewart. Dated December 3rd.

27,588. "Improved insulating material for electric conductors." F. Hawkins. Dated December 3rd.

27,629. "Improvements in or applicable to ceiling roses for electric lamps." E. Acheson. Dated December 4th.

27,695. "Improvements in or relating to the insulation of electric conductors." F. Hawkins. Dated December 4th.

27,696 "Improvements relating to electrically propelled vehicles." F. L. Muirhead. Dated December 4th.

27,701. "Improvements in and in connection with the manufacture of electrodes for secondary electric batteries." H. Leitner. Dated December 4th.

27,706. "Improvements in or connected with circuit closers for electric bells." J. Newton. Dated December 4th. (*Complete.*)

27,736. "Improvements in conducting arrangements for electric railways and tramways." E. Hopkinson. Dated December 5th.

27,753. "Improvements in electrical measuring apparatus." W. O. Smith, G. K. B. Elphinstone, and A. C. Heap. Dated December 5th.

27,754. "Improvements in electrical ignition apparatus for oil and gas engines and the like." A. G. New. Dated December 5th

27,776. "Improvements in or connected with the obtainment of metals or alloys by electrolysis or by hydro-electro-chemical action." P. Marino. Dated December 5th.

27,809. "Improvements in electric safety fuses." M. B Cotterell and H. Russel. Dated December 5th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d.* (*in stamps*).]

1895.

13,459. "Improvements in the manufacture and production of electric cables or conductors." G. E. Heyl. Dated July 12th, 1895. Conductors or cables are rendered air and waterproof by passing the conductor with closed ends through a bath of melted material, such as resin oil or oxidised mineral oil. The armoured and preferably paper insulated conductors are plugged to close the ends, the bare wires alone passing through. The cable is gradually withdrawn from the bath of melted material. 1 claim.

13,530. "Improvements in telephones." A. Hamm, G. Blank, V. Brandt, and G. Kabmendy. Dated July 13th, 1895. Telephones are arranged with the microphone and battery connected to the primary of a ring inductor. The secondary of the inductor is in circuit with the receiver and line, and is also connected to earth. Two or more inductors may be employed at each station in which case the secondary of that one in connection with the microphone is connected to the primary of the next towards that one whose secondary is connected to the receiver. 1 claim.

13,619. "Improvements in and connected with underground conductors for electric railways and tramways." J. Wetter. (Elektrizitats Aktiengesellschaft vorm. Shuckert & Co., Germany.) Dated July 16th, 1895. Relates to a sectional conductor or road contact system with electro-magnetic switches. Conductors, switches. The coils of the electro-magnetic switches are connected by separate conductors containing resistances, so that only sections near the vehicle are energised. The resistances may be formed as coils reinforcing the magnet coils, and may be in duplicate so as to serve as magnetising and demagnetising coils. The switching devices may be placed in a table or may be grouped in boxes. 2 claims.

1896.

3,082. "Improvements in armatures for induction motors." A L. Cushman. Dated February 11th, 1896. The coils of an armature for induction motors, are composed of an active high resistance portion and two or more low resistance portions. The high resistance portion and one of the low resistance portion being constantly in series and a switch so arranged as to connect the second low resistance portion in multiple with the high resistance portion. 3 claims.

3,682. "An improvement in multiple contact circular electric switches." Siemens Bros. & Co., Ltd., and Z. H. Kingdon. Dated February 18th, 1896. The switch has provided on its brush axis a wheel with notches and hollows in its periphery engaged repectively by a pin or tooth and a boss on the axis of the handle. 1 claim.